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METAL INDUSTRY

THE JOURNAL OF NON-FERROUS METALS

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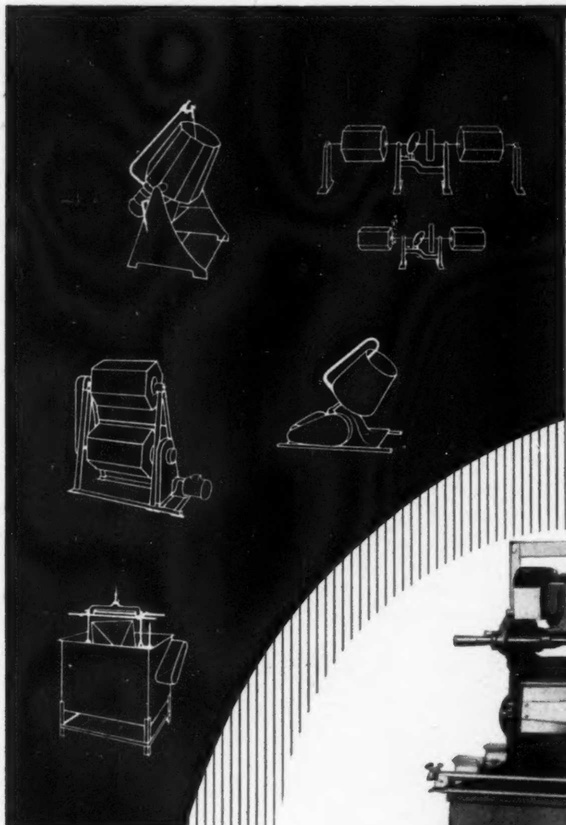

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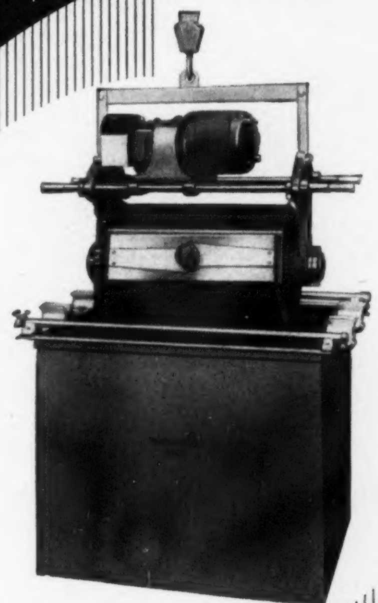

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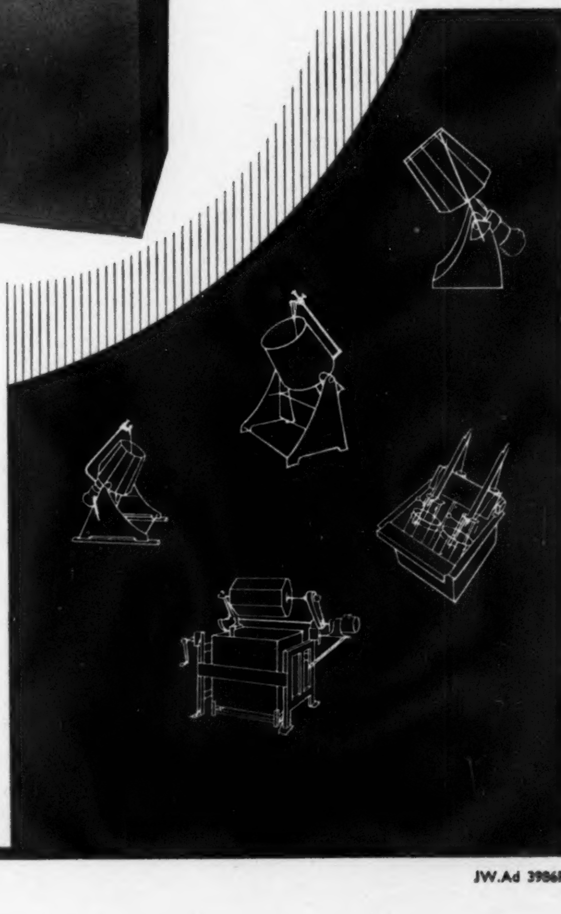

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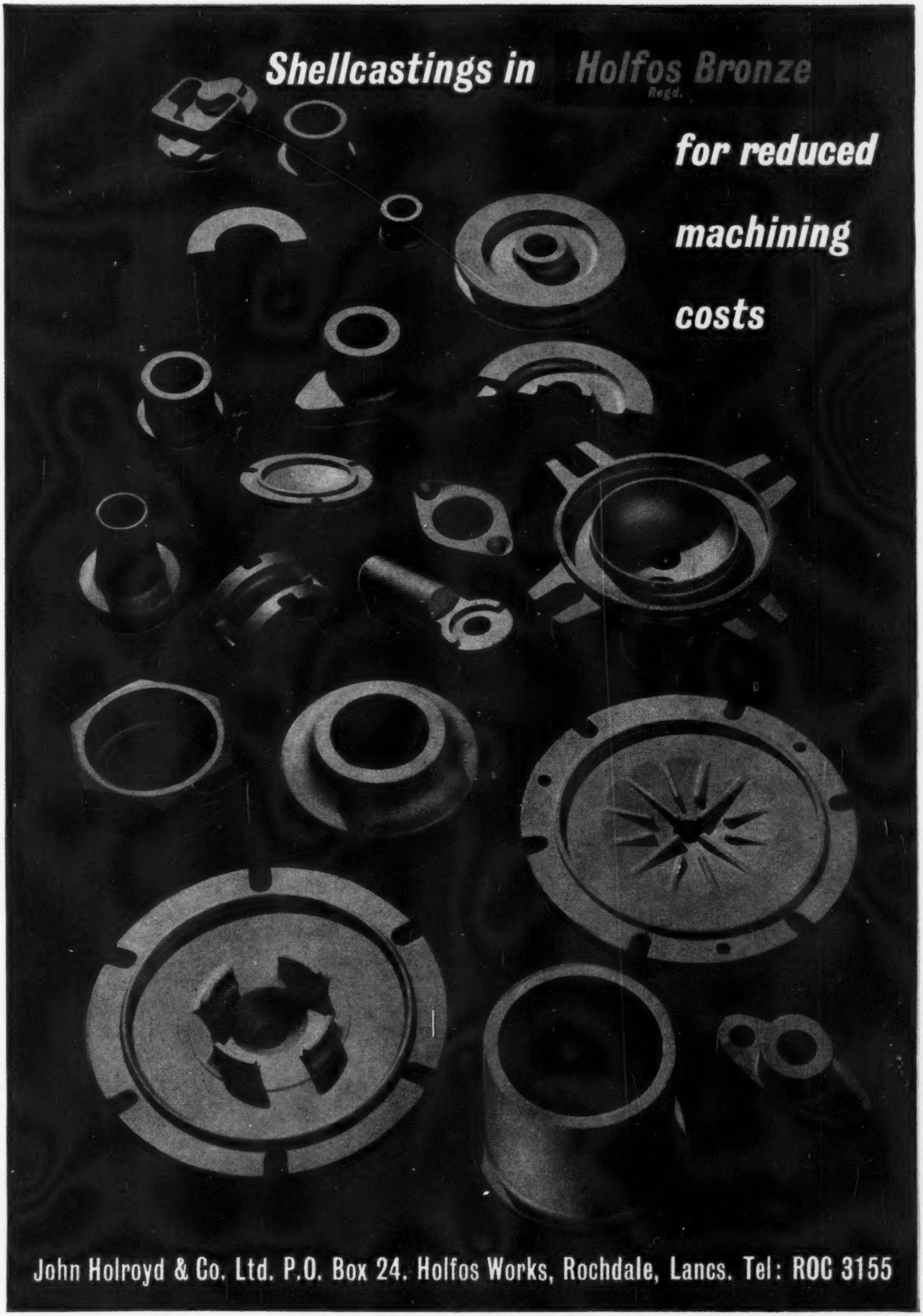
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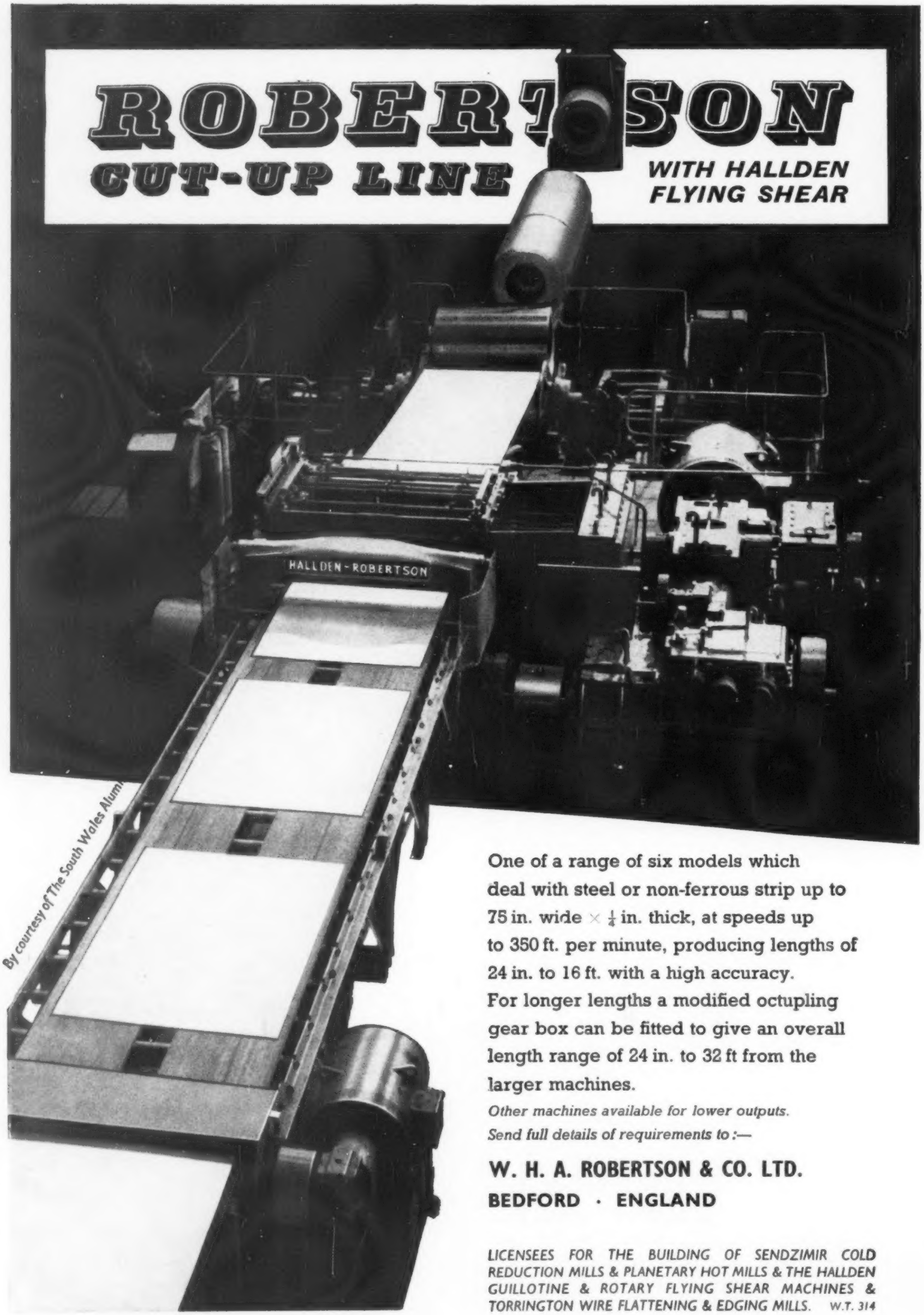

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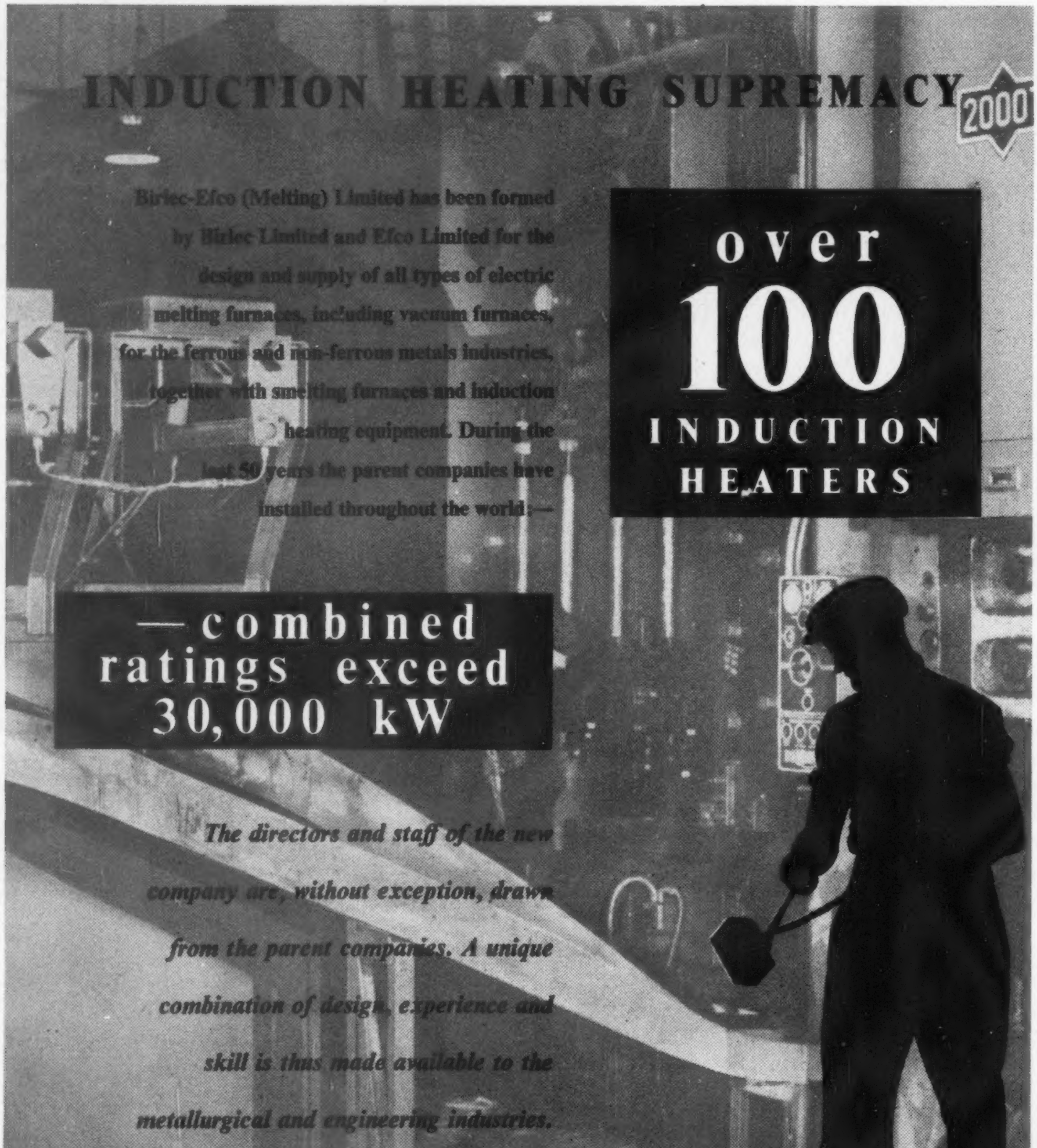
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METAL INDUSTRY

FOUNDED 1909

EDITOR: L. G. BERESFORD, B.Sc., F.I.M.

23 JANUARY 1959 VOLUME 94 NUMBER 4

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PUBLISHED EVERY FRIDAY BY ILIFFE & SONS LIMITED

Editorial Offices: 9 Charlotte Street, Birmingham 3 . Telephone: Central 3206

Advertising and Publishing Offices: Dorset House, Stamford Street, London, S.E.1. Tel.: Waterloo 3333. 'Grams: "Metustry, Sedist, London"

Branch Offices: MANCHESTER: 260 DEANSGATE, 3; telephone, Blackfriars 4412 and Deansgate 3595. BIRMINGHAM: KING EDWARD HOUSE, NEW STREET, 2; telephone, Midland 7191. COVENTRY: 8-10 CORPORATION STREET; telephone, Coventry 25210. GLASGOW: 26a RENFIELD STREET, C2; telephone, Central 1265

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METAL INDUSTRY

VOLUME 94 NUMBER 4 23 JANUARY 1959

Loans for Industry

ALTHOUGH the general level of employment since the war has been high, there are still areas where unemployment is above the average and where jobs are needed. National efficiency requires that full use be made of all the labour and physical resources available. To this end it is the policy of the Government, through the Board of Trade, to restrain industrial development in some congested areas, and encourage it in those of high and persistent unemployment. As an inducement, financial assistance is now available to firms willing to set up, or expand, in such areas in both Great Britain and Northern Ireland.

Under the Distribution of Industry (Industrial Finance) Act, 1958, all kinds of trades or businesses are eligible for assistance provided they have plans which will help to reduce unemployment in one of the scheduled areas. They need not be located in one of these areas so long as people can travel from them to the new work. A concern already established, but desirous and capable of expansion, may qualify just as well as a new venture. The Act requires, however, that the Board of Trade be satisfied that the financial assistance applied for is likely to reduce unemployment. At the same time, the Treasury has to be satisfied that the necessary capital cannot be obtained elsewhere "on the requisite terms."

Broadly speaking, "requisite terms" means the terms which are needed to enable a particular undertaking to have a reasonable chance of success *in the place proposed*. In other words, the circumstances in which the project will be carried on will be taken into account in considering whether or not the requisite terms can be obtained from the normal sources of capital. It is not necessary to prove that the capital required cannot be raised on any terms at all. It is essential, however, to show that the new project is eventually likely to prove economic, but that before this stage is reached financial assistance is needed on terms which cannot be obtained from commercial sources.

Financial assistance is available in the form of loans or annual grants; in some cases both may be made, although the usual form is naturally by way of loan. Annual grants may be made towards the cost of paying interest on money borrowed from commercial sources, or to help with abnormal initial expenses arising from the choice of a place which makes the project temporarily uneconomic, such as the cost of clearing a site, building an approach road or railway track, or training new labour.

In considering proposals for financial assistance the Treasury will be advised by a committee of businessmen. This committee will need to know the nature of the project and the area in which it is proposed to operate; the amount required, whether in the form of annual grants, a loan, or a combination of both; how the total available finance is to be used; what attempts have been made to obtain capital for the undertaking from any other sources; and details of the present labour force (with separate figures for men and women), the probable changes in it for each of the next three years, and of any unusual labour requirements, e.g. for workers with special skills or for boys and girls under 18. Should the committee decide that the application is eligible for further consideration, supplementary information, similar to that which would be required by a commercial lender, will be asked for.

Any scheme that will help to banish the spectre of mass unemployment is certainly a step in the right direction, and the fact that such assistance is available cannot be too widely made known. By taking advantage of the scheme, which up to now has not been well supported, employers will be helping the community, improving the market for business generally, and possibly helping themselves also.

C

Out of the MELTING POT

To the Job

COMPLAINTS, such as the one aired here recently (this page, METAL INDUSTRY, 19 December, 1958, p. 508), to the effect that ultrasonic generators of the magnetostriction or piezoelectric type are not powerful enough for the jobs they could do in metal working and metal treatment, can be countered in several ways. One way, indicated at the time, would be the adoption of one of the less elaborate mechanical means of generating vibrations. In this connection it is, perhaps, worth pointing to the fact that far too little attention is being given in general to the possibilities of putting vibrations to good uses. What could be the effect of vibrating extrusion and drawing dies, for example, or feeding a beam of ultrasonic vibrations into the work through the shank and tip of a cutting tool? But to return to this problem of the inadequate size and power of ultrasonic generators. There is yet another way of getting over the limitations imposed by this inadequacy. Essentially, it involves arranging matters in such a way that instead of acting upon a stationary "workpiece," whatever it may be, of a size for which the power of the ultrasonic vibrations available is inadequate, the self-same vibrations are made to act upon a suitably small portion of a moving "workpiece"; in other words, by changing the particular process from a batch to a continuous type. In casting, this would mean a progressive building up of the casting from molten metal, which would be allowed to solidify as it was cast, being subjected to vibration in the process. In surface treatment this would mean the movement of the work through the treating medium in a zone of ultrasonic vibrations or, alternatively, the movement of the medium, e.g. in the form of a jet, and of the zone of ultrasonic vibrations over the surface of the work. An interesting example of the first of these alternatives is provided by a method suggested for cleaning grinding wheels in order to keep their surface free from "loading." In this method, which is particularly useful in fine grinding operations, the grinding liquid is supplied to a small chamber positioned, with a small clearance with an open side, against the working surface of the wheel. The liquid which escapes through the clearance is collected in a trough arranged below the wheel, and is recirculated after filtration. To effect the cleaning, a beam of ultrasonic vibrations is directed at the surface of the wheel through the liquid in the chamber.

How Necessary?

PRODUCED under the same conditions, heat-treated in the same way, having the same microstructure, and finished to the same degree of surface smoothness and cleanliness, two specimens of metal might be regarded as identical if only it were not for the difference, however slight, in their behaviour when put into a fatigue testing machine or immersed in such a "simple" substance as tap water. Of course, the variation may not be entirely due to the material or product. A standardized fatigue test or a corrosion test involving immersion in tap water cannot be entirely free from uncertainty, and the same must be true of the composite environmental testing procedures that nowadays are being devised to simulate the out-of-the-way conditions which materials and products may encounter in service. Unfortunately, two uncertainties do not add up to a certainty. Whatever they do add up to does suggest, however, that some of the efforts expended in earlier stages on precision in the matter of measuring and controlling simple properties and, in the later stages, on the accuracy of the addition of all these properties, ought perhaps to be given some consideration in relation to these unavoidable uncertainties of the product and of the circumstances of its subsequent service and life. In view of the emphasis on more and more control, it is just a little too easy to lose sight of the fact that exceeding the appropriate limit in the search for perfection in that respect is as profitless and incongruous as the more obvious and more readily avoided *faux pas* of unnecessary precision used in the wrong circumstances.

Possible Revelations

MEASUREMENTS of electrode potentials are one of the ways in which information could be obtained regarding the effects of elastic and plastic deformation of a metal on the surface of the metal. From this information some conclusions could then be derived as to the effect of such changes on the relation between the surface and the medium surrounding it, and then as to the effects any resulting modification of this relation might, in turn, have on the behaviour of the metal in elastic and plastic deformation. Investigations on the effect of stress on the electrode potentials of metals have been carried out on many occasions in the past, the value of the information derived from them for the purpose referred to above increasing as more and more accurate measuring instruments became available for these measurements. Thus, one of the latest of such investigations, in which the electrical potentials of copper wires stressed in torsion were studied, made use of a low-noise level D.C. breaker amplifier which was capable of measuring voltages as low as one microvolt. The wires used were 12, 14, and 16 B. and S. gauge, of hard drawn copper. The electrode potential of the wire subjected to torsion was measured against an electrode of the same, but unstressed, wire in an electrolyte consisting of 1*N* sodium chloride. The test specimens were electropolished. In every case there was an initial potential between the wires before one of them had been stressed. This potential was large compared with the stress-induced potential, and had to be balanced by the application of an opposing voltage. As one of the wires was twisted, it became more anodic with respect to the unstressed wire, the value of the electrical potential induced by stress being proportional to the square of the torsion below the elastic limit. A drop in this potential occurred when plastic deformation started at the yield point of the wire. If the metal was then allowed to set and torsion was again applied, the potential increased parabolically with torsion as before. These results, which are in agreement with expressions derived from theoretical considerations, indicate, as the investigators point out, that similar measurements of potential may provide information significant to fundamental studies of fatigue and creep.

Skimmer

MOLYBDENUM — NIOBIUM — TANTALUM — RHENIUM — TUNGSTEN

Fabrication of Refractory Metals

By W. L. BRUCKART

Molybdenum, niobium, tantalum, rhenium and tungsten together form a group of refractory metals that are receiving more attention as their applications become more widespread. In this article, a condensed version of a Paper presented to the American Society of Tool Engineers, the author discusses their properties, forming and machining, and a number of applications.

ALTHOUGH no exact definition has been named as standard, it is generally considered that refractory metals are those having melting temperatures in excess of 1,925°C. There is a further classification of refractory metals into two groups: noble (the platinum group) and non-noble. Fabrication of the noble metals in the refractory metals series is a very well established art quite widely practised by the jewellery trade. The remaining metals in the refractory metals series—niobium, molybdenum, tantalum, rhenium, and tungsten—will be dealt with here.

With the exception of rhenium, which is still generally of academic interest only, these four metals have crossed the threshold separating the laboratory curiosities from engineering materials of construction, and are now growing in importance and breadth of use. The development rate of these materials will in many ways be dependent upon the rate at which the art of fabrication is extended to cover them, and thus to assist in their transition from the category of new and special engineering materials to that of commonly used engineering materials.

In Table I, some of the basic properties are listed for the five metals under consideration. In all cases these metals are single phase materials, that is, there are no precipitated or ageing phases, and since they are pure metals, and do not change their crystal structure on heating, there can be but one homogeneous structure. Further, these metals are all strengthened by working, or by solid solution alloying: there are no commercially available precipitation hardening grades of these materials. In other words, they are not heat-treatable in the accepted sense. They may be stress relieved or annealed, however. Their good workability can be impaired in all cases by careless handling, particularly by heating in air to very high temperatures, such as 1,100°C. or higher. Such treatment generally results in contamination of niobium and tantalum, and causes loss of metal by volatilization of the rhenium to rhenium oxide. Tungsten and molybdenum lose metal by volatilization of their oxides, and also suffer surface penetration of oxides, resulting in embrittlement of varying degrees.

Whereas molybdenum and certain molybdenum-base alloys are available in very large sizes, owing to the arc melting consolidation of the metal, the remaining metals are the product of powder metallurgy consolidation, and hence are limited to smaller unit sizes. Niobium and tantalum are also being experimented with as arc meltable metal.

The fabrication of these metals can be described only generally, but this information should serve as guidance from which the operator should be able to develop specific "feel" for the material and its handling during fabrication. The majority of the information to be given is on molybdenum, because it is more difficult to handle than tantalum and niobium, and is being used more than tungsten in non-electronic applications.

Molybdenum

Molybdenum is a stiff metal (high modulus) which is not very hard, and about as strong at room temperature as mild steel (see Table I). It is about 30 per cent heavier than the average steel, and looks very much like steel in colour and surface appearance. For this reason, one should make certain that the identification of molybdenum is kept, in order that spoilage may be prevented should it be mistaken for steel in the shop. Also, from Table I, it will be seen that molybdenum has a very high thermal conductivity. Coupled with this high thermal conductivity is a very low heat capacity. This means that molybdenum is very readily heated, and consequently it cools off very rapidly. Thus, when working with molybdenum where heat is needed for the proper forming of the material, one should remember that it may be necessary to supply a constant input of heat, such as from a torch, infra-red lamp, or similar device.

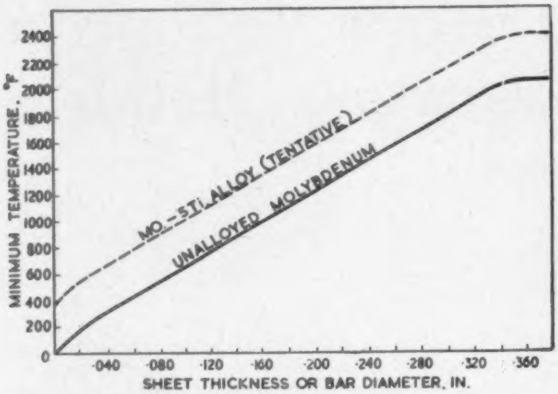
Commercial molybdenum alloys to-day are limited to molybdenum-0·5 per cent titanium, and two powder metallurgy grades: molybdenum with 0·1 per cent colbalt and molybdenum with 50 per cent tungsten. The molybdenum-cobalt grade behaves very much like pure molybdenum, and will be discussed as pure molybdenum. The molybdenum-50 per cent tungsten alloy behaves in a manner intermediate to molybdenum and tungsten, and its handling will be inferred from the discussion of molybdenum and of tungsten. The molybdenum-0·5 per

TABLE I—BASIC DATA ON REFRACTORY METALS

	Approximate Room Temperature Mechanical Properties[1]							Room Temperature Thermal Properties	
Metal	Melting Point °C	Density lb/in³	Vickers Hardness	Yield Strength lb/in²	Tensile Strength lb/in²	Elongation per cent	Modulus of Elasticity lb/in²	Conductivity B.Th.U/ft²/in °F/sec	Expansion $\times 10^6$
Niobium	2416	0·310	100–150	20-30,000	35-50,000	30–50	$12{\cdot}5 \times 10^6$	0·064	4·1
Molybdenum	2627	0·369	200–250	75-100,000	85-110,000	10–25	$47{\cdot}5 \times 10^6$	0·282	2·7
Tantalum	2996	0·600	125–180	25-40,000	50-75,000	30–50	27×10^6	0·068	3·6
Rhenium	3171	0·72	250–450	30-140,000	150-170,000	10–25	$66{\cdot}5 \times 10^6$	—	12·25
Tungsten[2]	3410	0·697	350–500	120-165,000	150-210,000	1–4	59×10^6	0·25	7·9

(1) *In condition most suitable for further fabrication, e.g. molybdenum and tungsten stress relieved ; niobium, tantalum and rhenium recrystallize annealed.*

(2) *Data are for swaged bar and wire only* (0·04 *in.*—0·008 *in. diameter*).

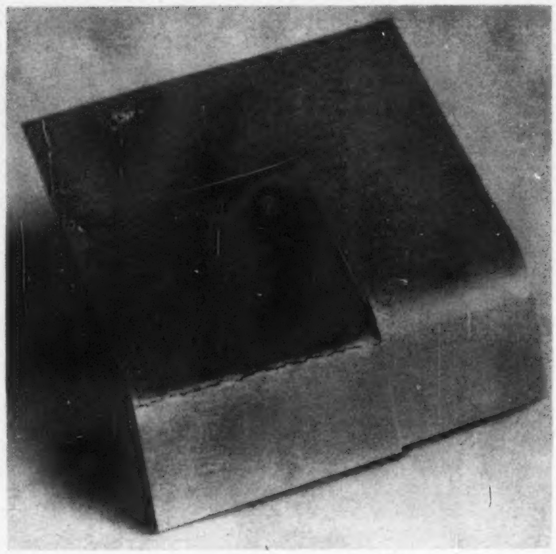


This temperature-thickness plot should serve as a guide in the following operations: Shearing, spinning, stamping or punching, floturning, hydroforming, bending, stretch forming, deep drawing.

For sawing where a handsaw is used, the material should be warmed according to thickness up to about 400°F. maximum.

This does not apply where welded sections are involved. Up to $\frac{1}{4}$ in. welded sections should be heated to 1,800-2,000°F., and heavier sections, up to 2,350°F

Fig. 1—Suggested minimum working temperatures for molybdenum and molybdenum-0·5 titanium shapes



[Courtesy Fansteel Metallurgical Corporation

Fig. 2—Result of bending molybdenum below and in the proper temperature range

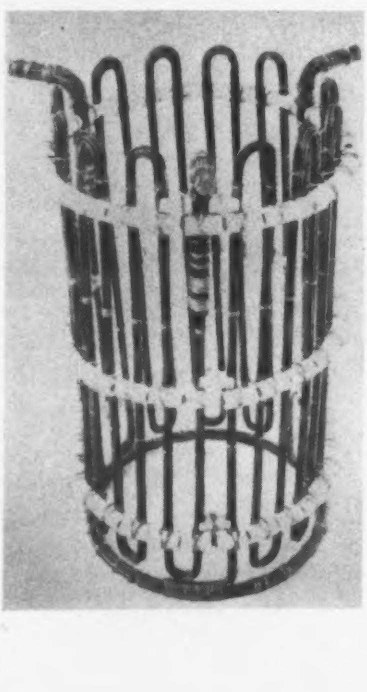
cent titanium alloy behaviour makes it somewhat more difficult than unalloyed molybdenum, and it will be discussed along with pure molybdenum on a comparative basis.

The uses of molybdenum are numerous, but future uses will be dependent upon demands for its unusual combination of mechanical properties plus the degree of familiarity possessed by fabricators and designers with molybdenum.

Fabrication of Molybdenum

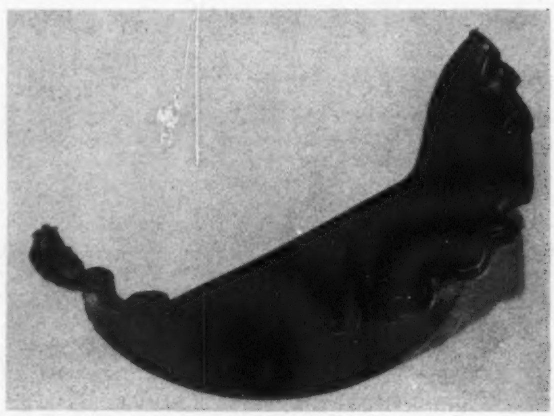
Molybdenum can be formed readily without any particular difficulty provided some general rules and precautions are followed. Cold forming should be avoided generally, except where the forming of very thin sheet or fine wire is considered. Even with these materials, the forming temperature should be at least 20°C. As can be seen in Fig. 1, the forming temperature requirements vary linearly with the thickness of the sheet or diameter of the bar. The smooth lines presented in Fig. 1 are a conservative representation of the large quantity of practical experience data. One can form molybdenum at temperatures below the lines indicated, but the chances for successful 100 per cent reproducible forming diminish as one deviates below the minimum suggested temperature.

Bending and twisting operations may be accomplished free hand, or they may be performed over a guiding radius. The latter is preferred, and a slow rate of deformation should be



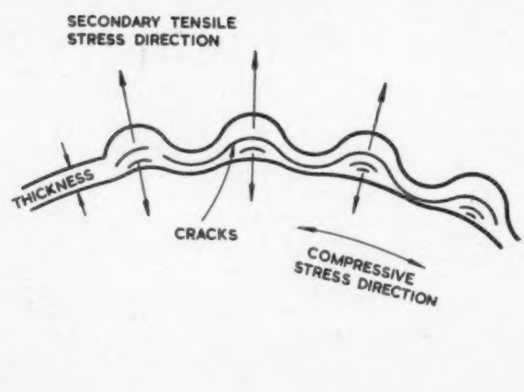
[Courtesy Metallwerke Plansee

Left: Fig. 3—Example of molybdenum wire (heating element) fabrication



[Courtesy Marquardt Aircraft Co.

Above right: Fig 4a—Failure of molybdenum sheet due to improper spinning technique

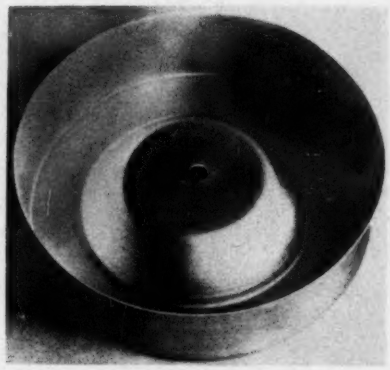


Right: Fig. 4b—Secondary tensile failure resulting from compressive bending

ensured at all times. In performing these operations, temperature should always be taken into account, as indicated in Fig. 1. An example of the effect of bending cold versus bending warm is shown in Fig. 2. Molybdenum and most molybdenum alloys will successfully bend over a radius which is twice the thickness of the sheet or bar being bent. In very thin sheet sections, or fine gauge wire, particularly less than 0·040 in. diameter or thickness, bends may be made over radii of less than one thickness. An illustration of the formability of molybdenum in wire form is shown in Fig. 3, in which 0·080 in. diameter molybdenum wire is wound in a cylinder-shaped cage for use in a resistance heated furnace.

Molybdenum has been successfully spun in thicknesses up to approximately $\frac{3}{8}$ in. and in diameters up to 10 in. at this thickness, and 20 in. in lesser thicknesses. If it were not for limitations imposed on the operator by spinning-machinery bearings becoming overheated, and lack of proper leverage, heavier gauges and larger diameter pieces might be spun quite readily. Temperatures for spinning conform to those shown in Fig. 1. It is common to use some plastics wax, or soapy type of lubricant, when spinning molybdenum.

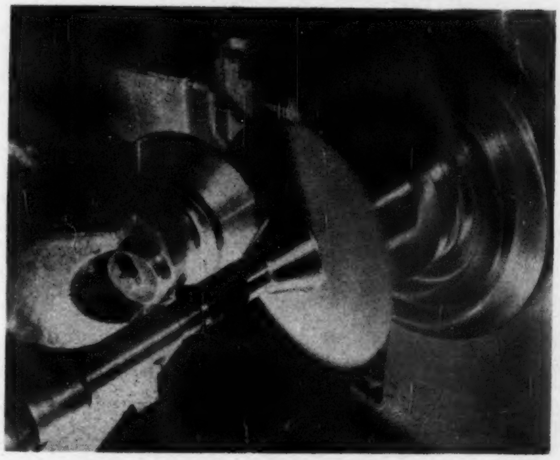
Until experience is gained in the proper method of working the outer edge to prevent buckling, the work must be removed periodically so that the scalloped edge can be removed prior to the development of cracks and failures such as are shown in Fig. 4a. One of the very important points to be remembered about the fabrication of molybdenum and its alloys is illustrated in Fig. 4b. If it is remembered that molybdenum is very weak in the thickness direction, much breakage will be prevented. In all operations where it is possible to develop secondary tensile stresses in the thickness direction, it is vital to prepare proper tooling and working temperatures in advance of production runs. An example of a satisfactorily-spun molybdenum piece is shown in Fig. 5. The particular object shown was made from a 20 in. diameter piece of molybdenum 0·090 in. thick, and was spun at 260°-320°C. In Fig. 6 is shown a somewhat similar spun shape made from much thinner gauge material.



Top left : Fig. 5—Molybdenum collar spun from 0·090 in. thick sheet

[Courtesy Fansteel Metallurgical Corporation

Top right : Fig. 6—Spun molybdenum special shapes

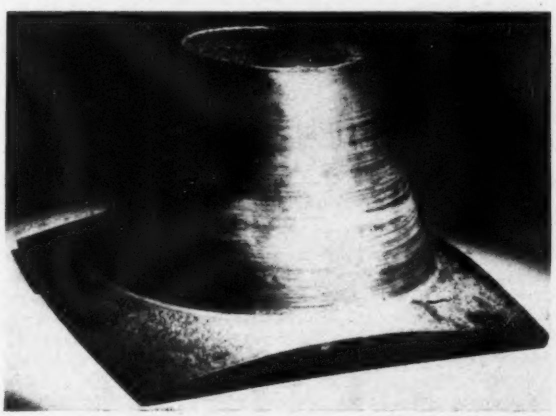


[Courtesy Lodge and Shipley

Right : Fig. 7—Floturning operation

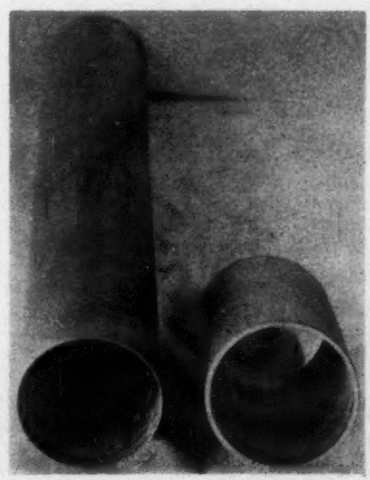
Floturning (hydrospinning) is readily conducted on molybdenum, as illustrated in Fig. 7. A floturned object is shown in Fig. 8. When the starting stock is a flat piece, and the object to be manufactured can be finished directly on the floturner, only one form is necessary. Whenever wall thickness must be reasonably heavy, or a parallel wall finished product is required, the starting stock must either be tubing (manufactured either by spinning or by extrusion, as shown in Fig. 9), or flat stock which must be progressively formed over a number of dies until the final shape is produced, or until a shape suitable for floturning is manufactured. A series of such dies is illustrated in Fig. 10. These dies were used to convert 0·3 in. thick molybdenum plate, 10 in. diameter, to 3 in. diameter cylinders having 0·3 in. thick walls.

Since the molybdenum was of such heavy gauge, it was necessary to



[Courtesy Climax Molybdenum

Left: Fig. 8—Floturned molybdenum object



[Courtesy Hunter Douglas

Right : Fig 9—Extruded molybdenum tubing suitable for spinning

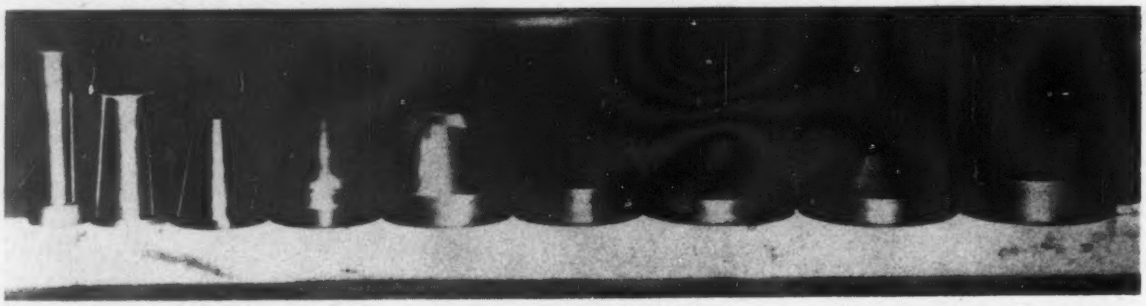


Fig. 10—Die series required to spin molybdenum plate to cylinder properly and retain original gauge [Courtesy, Hydrometal Spinning

conduct this work at 980°-1,100°C. Much smoke is generated in operations of this nature, conducted at such high temperatures, and heat must be continuously supplied, in this case by oxy-acetylene torches. Fig. 11 is an illustration of two types of failure which will occur in molybdenum sheet on which spinning or floturning has been improperly attempted. In the illustration, the molybdenum sheet was spun at far too low a temperature, and the product which was furnished for spinning had been given excessive working, without proper stress relief, prior to its submission for spinning.

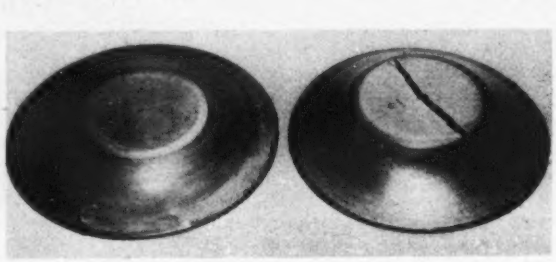


Fig. 11—Failure of molybdenum sheet to spin resulting from overworked sheet and insufficient spinning temperature

In all cases of the working of molybdenum, material should be furnished in the stress relieved condition, and particularly in the case of spinning and floturning operations, the material should be specified as cross rolled product.

(To be continued)

Men and Metals

New directors have just been appointed to the board of Imperial Chemical Industries Limited as follows:—**Mr. G. K. Hampshire,** chairman of the company's General Chemicals Division, and **Dr. J. S. Gourlay,** chairman of the Paints Division, both appointments to take effect from February 2 next. Mr. Hampshire joined Brunner Mond—one of the original constituent companies—in 1923, and in 1933 was appointed sales manager of the general chemicals group. Dr. Gourlay was originally a laboratory apprentice with Nobels' Explosives Company Limited at Ardeer from 1919. Ten years later—having in the interim obtained his science degree from London University—he was transferred to the Stowmarket factory of Nobel Chemical Finishes Limited, and eventually became research manager of the Paints Division of I.C.I. in 1945. He became chairman of the division in 1957. He obtained his Ph.D. from London University in 1935.

On January 1 last, the twenty-fifth anniversary of his joining the company, **Mr. J. H. Mayes,** director and general sales manager of Northern Aluminium Company Limited, was presented with an aluminium clock. Mr. Mayes has been in the sales department for all but three of his twenty-five years with the company. He was appointed general sales manager in 1957.

Elected to the board of Aluminium Limited, **Mr. Fraser W. Bruce** is also President of that company's principal operating subsidiary, the Aluminum Company of Canada. It is also announced that **Mr. Melvin P. Weigel** has been elected a member of the board of the Aluminum Company of Canada. He is also director of operations of the parent company.

Advance Motor Supplies Limited, one of the Sheepbridge Engineering group, announce that **Mr. G. N. Freeth** is now branch manager at the company's Birmingham branch.

Changes in the organization of Vickers Limited have been announced as follows:—**Lieut.-Cmdr. R. B. Lakin,** D.S.O., D.S.C., has been appointed a special director of Vickers-Armstrongs (Engineers) Limited, and deputy general manager of the Elswick, Scotswood and Wakefield works of that company. He relinquishes his seat on the board of George Mann and Company Limited. **Col. H. S. J. Jelf,** C.B.E., has been appointed a director of George Mann and Company Limited, and also managing director of that company.

Consequent upon his retirement as managing director of Fescol Limited, **Mr. R. E. Wilson** is succeeded in that position by **Mr. F. B. Strachan,** previously assistant managing director. Other appointments within the company announced are the following:—**Mr. W. A. Leslie** continues as director and sales manager; **Mr. F. Baden,** works manager of Port Glasgow, transfers to London as works manager of the London works; **Mr. C. W. Hay,** works manager at Huddersfield, is appointed works manager of Port Glasgow, and **Mr. A. E. Lockley** is appointed works manager at Huddersfield.

On Thursday of last week, **Mr. Hugh D. Binyon,** instrument sales director of the Solartron Electronic Group Limited, left London by air for New Delhi to attend the India Science Congress, and to be present at the stand of the Solartron group at the exhibition held in association with the Congress.

Bending Aluminium

ADDRESSED mainly to production engineers, designers, draughtsmen, works managers, and foremen, Information Bulletin 24, "Bending Aluminium," issued by the Aluminium Development Association, is also intended to be of help to operators and apprentices.

The Bulletin opens with a classification of aluminium and its alloys, primarily as between the non-heat-treatable and heat-treatable groups, and continues with factors affecting the choice of materials for bending or flanging. Brief notes on the bending properties of aluminium, including the important matter of spring back, complete the preliminary pages and lead to the major section of the publication dealing with the bending operations.

This booklet is available from the Association at 33 Grosvenor Street, London, W.1.

Atomic Progress

Fuel Element Performance

IN this article the performance of Calder fuel elements will be discussed in general terms. For this purpose reference will be made to two Papers,[1,2] both of which were presented at the 2nd Geneva Conference on Atomic Energy.

Irradiation Creep Behaviour

The preceding article in this series (METAL INDUSTRY, 26 December 1958, p. 536) dealt with the phenomenon of irradiation creep and, in particular, the evidence of Roberts and Cottrell.[3] That work suggested that irradiation sets up a creep rate in uranium in the range 0·4 to 1·4 elastic deflections/MWD/te (MWD/te=megawatt days per tonne) at low stresses and temperatures in the range 100°-330°C. Preliminary experiments with horizontal fuel elements, supported at each end, in the Windscale piles[1] confirmed the effect.

Hardy and Lawton[2] consider the effect of irradiation creep on the deflection or bowing of a vertically-loaded uranium fuel element. Starting with an initial bow of 0·025 in. and taking the most pessimistic creep rate of 1·4 elastic deflections/MWD/te, they calculated fuel element bow doubling irradiations of 38, 46, and 60 MWD/te for elements 1, 2, and 3, numbered from the bottom of the channels. Had they used the most optimistic irradiation creep rate, these values would be increased by a factor of not more than three. Eldred and his co-workers[1] predicted from their experiments that, for an initial bow of 0·025 in., fuel elements in a number 2 channel position would develop a bow of 1·0 in. in about 550 MWD/te. Such badly bowed fuel elements would be difficult to discharge.

In order to check these predictions, some fuel elements were discharged during an early shut down of No. 1 reactor. Measurements of bow were made radiographically in a concrete cave at Windscale. Six radiographs were taken at intervals of 30° as the fuel element was rotated on its axis. With the aid of the shadow of a steel straight edge recorded on the film simultaneously as a datum line, it was possible to measure the apparent bow on each film. The maximum true bow was obtained graphically from these measurements. Some of the early results, together with more recent values are given in Table I.

These results amply bore out the predictions. Remedial measures were, therefore, necessary and took the form of a magnesium alloy brace attached to the can about its mid-point. These braces consist of several blades which are held against the tops of the fins on the cans and touch the channel wall at an early stage of bowing. This lateral support at the middle of the fuel element, additional to that already provided at the ends, reduced the effective length of the fuel element by a half. Examination of fuel elements fitted with these braces has shown them to be effective in restraining bowing. Complex bowing will, no doubt, develop at high irradiations, but no evidence for this is given in either report.

TABLE I—RESULTS OF BOWING TESTS

Fuel Element Position In Channel	Observed Doubling Irradiation (MWD/te)	Present Average Doubling Irradiation	Present Doubling Times In Days
1 (Bottom)	94	140	89
2	66, 97, 76	140	49
3	80, 95, 84	140	41
4	88, 77, 93	210	60
5	273, 65	160	55
6 (top)	—	170	106

Comparison of the recent data with that obtained earlier (see Table I) suggests a developing resistance to creep. A possible explanation of this may be the increased time necessary for internal stresses to build up if there has been irradiation hardening. Eldred's Paper indicates that hardening does occur, but the results quoted suggest considerable variation with temperature.

Thermal Creep Behaviour

Hardy and Lawton[2] also consider the bowing of Calder fuel elements under thermal creep. A theoretical analysis gave bow doubling times of 230, 100, 240 and 2,200 days respectively for elements in channel positions 3, 4, 5, and 6. The first analysis contained various simplifications:—

(a) The temperature along the length of the rod was taken as constant. This might have an appreciable effect on the creep behaviour, but the weakest element (No. 4) has a temperature variation of no more than about 30°C. along its length.

(b) It was assumed that the rods are weightless and withstand a load *P*. This approximation becomes steadily worse from the bottom to top of the stack.

(c) No allowance was made for slight deviations of the fuel element from vertical.

A revised analysis taking these features into account predicted increased rates of bow, especially for No. 6 element, but did not materially alter the bow doubling time except for very small initial bows.

Out-of-pile vertical strut tests gave the following results:—

Temperature (°C.)	Mean Load (lb.)	Doubling Time (days)
400	90	650
450	90	310

The temperatures used approximate to the assumed mean temperatures used in the calculations. These results were considered to be valuable confirmatory evidence.

In-pile data for elements 5 and 6 give bow doubling times of 55 and 106 days, i.e. much lower than expected under steady state thermal creep. This might be due to thermal cycling, relief of internal stresses, or perhaps even to the use of too low an effective temperature. In fuel elements 3 to 6, irradiation and thermal creep will both occur, the proportion of thermal creep increasing towards the top of the reactor. It is not yet known if there is an interaction between irradiation creep and thermal creep.

It can be seen from the data given in Table I that thermal creep of the top elements presents as important a problem as irradiation creep of the lowest fuel elements, and that bracing is also necessary to counter this.

Impact on Design

The irradiation and thermal creep characteristics of Calder fuel elements were particularly important to the fuel element designers for the first round of nuclear power stations. Clearly, bowing could be reduced by increasing the moment of inertia of the fuel rod, by shortening the fuel elements, by reducing the external load on each fuel element, or by providing some form of brace on the fuel element. The fuel elements exhibited at Geneva showed that all but one of these methods had been employed, and two schools of thought are apparent. The first school has chosen a slightly shorter fuel rod, than that for Calder, and placed reliance on full length braces to restrict bowing. The second school has reduced fuel element length to roughly half that of Calder elements,

(*Continued on page* 70)

Finishing Supplement

Light-Fast Organic Dyes for Anodizing

By Dr. R. C. SPOONER

Development of the properties of light-fast organic dyes for anodized aluminium has been in progress for some years, and this article, which appeared in "Metal Finishing," deals with the relative qualities of a number of such dyes as determined by a series of investigations carried out at Aluminium Laboratories Limited, Kingston, Ontario.

FOR many years the colouring of anodized aluminium articles by dyeing with organic dyes relied on the dyes readily available because of their use in dyeing various textiles. Some of these proved quite satisfactory, others failed to produce adequate colour, while many gave a good initial colour which, unfortunately, had poor light- or wash-fastness. Because of the limited demand, little interest was shown in the selection or development of dyes specifically for anodic coatings.

During and immediately after World War II, the commercial use of dyed anodic coatings steadily increased, but lack of adequate information about the proper use and the light-fastness of many of the available dyes caused unsatisfactory results. The available light-fastness ratings were based on standards developed for the textile industry, which were not adequate for use on anodic films, except for applications under mild interior conditions. In one case, a set of dyed anodized samples produced in India and forwarded to Canada for examination, arrived with little or none of the original colour apparent; the dyes had faded en route even though the specimens were in a closed container. In another case,[1] investigation of 250 dyes intended for anodizing panels revealed only 20 which passed a 400 hr. Fade-Ometer test.

The programme described here was initiated some years ago to select dyes with superior light fastness in commercial applications, and particularly in outdoor exposures.

Light-Fastness Test

A total of 115 organic dyes produced by 11 manufacturers was tested. Special efforts were made to include all dyes recommended at that time for colouring anodic films, and to employ them in accordance with the manufacturers' recommendations. Panels produced by the Aluminum Company of Canada Ltd., of special anodizing quality aluminium sheet (B.S.1470-1C clad with B.S.1470-1B) were cleaned by soaking in a hot, inhibited alkaline cleaning solution, anodized in a 15 per cent by weight sulphuric acid solution at either 15 or 18 amp/ft^2, dyed in aqueous solutions of various dyes at 60° to 70°C. for 10 min., and finally sealed in water at a *p*H of about 6·0 and at 95° to 100°C. for 30 min. The panels were rinsed in cold water after the various treatments. There was some variation in the anodizing time (30-40 min. except for black dyes, which required 40-50 min.) and temperature (21°-29°C.) of the solution. In later work a uniform time (30 min., 40 min. for black dyes) and temperature (21°C.) was adopted. Coating thickness was approximately 0·0005 in. (black dyes 0·0006 in.).

Sets of from 5 to 20 panels of 2½ in × 4½ in. size were prepared for each dye for exposure to indoor, Fade-Ometer, and outdoor (Kingston, Ontario) conditions. A few dyes of unsatisfactory promise were omitted from the latter two tests. The upper inch of each panel was masked with aluminium foil before initial exposure to preserve a band of the original colour. As colour changes appeared after appropriate periods, the foil mask was widened to protect an additional narrow band, which was marked accordingly. This procedure was continued throughout the test, thus producing a series of bands illustrating the colour after the various exposure periods.

The arbitrary colour grading system employed to describe the degree of fading was simple and direct. Dyed panels after each period of exposure were examined and the colour of the tested area compared with the initial colour and graded as follows:—Grade 5: No change or very slight change. Grade 4: Slight fading. Grade 3: Fading. Grade 2: Severe fading. Grade 1: Almost complete loss of colour.

The term "fading" included changes in shade or slight alterations in the colour. A change from "3" to "2," it was considered, would cause strong objection by a user and was, therefore, taken to constitute "Failure."

This method of evaluating the colour change on exposure has several limitations. All methods of visual evaluation of colour, and even many "instrument" appraisals, are influenced by personal bias. In the procedure used, determination of the point of "failure," that is, the change from a "3" to a "2" grading, is critically important. Independent gradings by several observers checked each other very well in estimation of this point and thus personal error, although present, was not large. A minor problem in grading was that exposure in a few cases, mainly outdoor exposure, was accompanied by surface weathering effects, such as decrease in lustre, mild surface chalking, and staining.

A light-fastness rating system based on the hours of Fade-Ometer exposure required to cause "failure" (change from a "3" to a "2" grade) was employed, as outlined in Table I.

Since this rating, at least with dyes of better light-fastness, included a broad range of exposure time (at least 250 hr.), slight errors due to personal bias in selecting the failure point had only minor effect.

Fade-Ometer light-fastness ratings based on the above system differ considerably from those assigned by manufacturers to specific dyes for anodic coatings. The performance scale used by the dye industry ranges from 1 (poorest) to 8 (best); ratings are determined by comparing the colour-fastness of the dyed anodic coating with that of eight blue textile colour-fastness standards. The light-fastness in the set roughly doubles from number to number. A set of these standards and the dyed aluminium sample are exposed together, generally in a Fade-Ometer, until the dyed anodic coating shows "definite fading" or "a break." The rating of the dye is the number of the standard which has equivalent light-fastness. The No. 8 standard usually fades with 500 hr. or less exposure. Dyes which show no "definite fading" within this period are classed as 8, although some dyed aluminium samples may require a very much longer period of exposure to cause this amount of colour change.

About 75 per cent of the dyes examined had only "poor" or "fair" Fade-Ometer ratings. However, among the remainder, 18 per cent gave "very good" or "excellent" ratings, that is, exposure periods of 500 hr. or more were required to cause "failure." Among this group were five dyes

TABLE I—LIGHT-FASTNESS RATING

Failure Between (hr.)	Light-Fastness Rating	
0 to 50	1	poor
50 to 100	2	poor
100 to 200	3	fair
200 to 300	4	fair
300 to 400	5	good
400 to 500	6	good
500 to 750	7	very good
750 to 1000	8	very good
1000 to 1500	9	excellent
More than 1500	10	excellent

TABLE II—NUMBER OF FAILURES

Exposure Time (Yrs.)	No. of Failures	Distribution of Failures Fade-Ometer Light-Fastness Rating									
		10	9	8	7	6	5	4	3	2	1
1	84			1	2	6	2	4	13	13	43
2	7		1	1	1			1	1	1	1
3·5	8	5	1	1			1				
5	0	1*	2*						1*		1*

**Had not failed at conclusion of test.*

TABLE III—DYES EXPOSED FIVE YEARS WITHOUT FAILURE

Dye	Solution		Fade-Ometer Light-Fastness Rating
	gm/L	*p*H	
Aluminium Black LLW	10	3·8	9
Alizarine Sapphire SE	4	6·5	9
Quinoline Yellow Conc. 180 per cent	4	5·0	10
Eloxan Red C-1	3	3·8	3
Alizarine Red S Conc. 110 per cent	4	5·5	1

which had not "failed" even after 1,500 hr. of exposure.

The 17 dyes with the better light-fastness, i.e. ratings of 1 or over, were distributed unevenly among the various colours, six in the blue, two in the orange, yellow, green, violet, and black, one in the red, and none in the brown and grey.

The panels were exposed indoors under mild service conditions. They were about 20 ft. from a south "window" wall partly screened from direct sunlight by Venetian blinds and, as would be expected, they lost colour at a much lower rate than those exposed outdoors. Of the dyes examined, a large number (37) failed within the first year but, during further exposure up to a total of four years, only 14 more failed. When the test was discontinued after four and a half years' exposure, 64 dyes, or about 56 per cent of the total number, still had a satisfactory, and in many cases excellent, colour.

There was good general agreement between the light-fastness of the dyes in this test with their Fade-Ometer ratings, although some of the dyes which retained satisfactory colours indoors had Fade-Ometer ratings as low as 1.

Most of the dyed panels "failed" after outdoor exposure for one year or less (see Table II). However, eight dyes withstood more than three years, while five still had a satisfactory, although faded, colour after five years of outdoor exposure at the conclusion of the test. The latter are listed in Table III. It should be noted here that the conditions of this test do not represent the recommended practice for dyed anodic coatings on material for outdoor exposure. Such coatings should be at least 0·001 in. thick.

The outdoor exposure results showed in general good correlation with the Fade-Ometer ratings (Table II), e.g. the majority of the dyes which failed within a year had low ratings. Ten of thirteen dyes which withstood three and a half years of the test had ratings of 8 or more. However, among the dyes which failed inside two years there were three with ratings of 8 or 9. Two red dyes (Table III) differed markedly in their resistance to fading, depending on the conditions. Although their Fade-Ometer ratings were only 1 and 3 respectively, both had satisfactory colour after five years of outdoor exposure. This particular result was of interest because dyes of this colour with superior light-fastness are not common, and are very much in demand.

Sealing Conditions

Sealing in nickel acetate solution is recommended by some dye manufacturers in place of water sealing in order to obtain improved light-fastness. This treatment often slightly changes the colour shade of the dyed work, indicating that the nickel acetate reacts in some way with the dyestuff which is absorbed on the oxide film.

The influence of this sealant was investigated in another series of tests with a set of twelve dyes (Table IV), all of good Fade-Ometer light-fastness. Panels prepared and dyed as described above were sealed in either water (30 min.), nickel acetate solution (5 gm/L., 5 min.), or nickel acetate solution (5 gm/L., 30 min.). All sealants had a *p*H of 5·6 and were maintained at 95°-100°C. These panels were exposed under the conditions of, and

TABLE IV—EFFECT OF SEALANT ON LIGHT-FASTNESS

Dye	Solution		Sealing**	Fade-Ometer Light-Fastness Rating	Outdoor Exposure Time to Failure (weeks)
	gm/L	*p*H			
Anodal Light Violet I	0·5	4·1	W	8	25
			N.A.5	7	36
			N.A.30	7	36
Al. Blue A	1·8	—	W	10	214*
			N.A.5	10	190
			N.A.30	10	115
Al. Gold Orange RLW	3	5·5	W	7	52
			N.A.5	10	162
			N.A.30	10	115
Al. Red GLW	4	8·7	W	3	25
			N.A.5	7	36
			N.A.30	6	36
Al. Bluish Green	5	3·4	W	5	115
			N.A.5	4	115
			N.A.30	4	25
Al. Black CL	6	4·1	W	6	52
			N.A.5	7	115
			N.A.30	7	80
Nigrosine 12525 Conc. Cryst.	12	6	W	7	36
			N.A.5	9	140
Metanil Yellow	2		N.A.30	9	162
Alizarine Sapphire SE	4	6·5	W	8	162
			N.A.5	10	214*
			N.A.30	10	214*
Nigrosine 12525 Conc. Cryst.	12	6·2	W	8	115
			N.A.5	10	52
			N.A.30	7	36
Quinoline Yellow Conc. 180 Per Cent	4	5·0	W	10	214*
			N.A.5	10	214*
			N.A.30	10	214*
Eloxan Turquoise D-1	3	7·6	W	10	214*
			N.A.5	10	115
			N.A.30	10	80
Alizarine Green GXN	4	5·7	W	4	115
			N.A.5	5	214*
			N.A.30	5	214*

**No colour failure even at conclusion of* 214 *weeks test.*

***W—water sealing; N.A.5—nickel acetate solution sealing* 5 *min.; N.A.30—similarly for* 30 *min.*

graded by, the system outlined earlier.

Comparison of the Fade-Ometer ratings and outdoor exposure results in this series for various dyes (Table IV) shows the wide divergence in light-fastness characteristics of the individual dyes. Anodal Light Violet, in spite of Fade-Ometer ratings of 7-8, failed outdoors in 25-36 weeks, and the method of sealing had little or no significant effect. Aluminium Bluish Green MLW had somewhat lower Fade-Ometer ratings (4-5) but the panels sealed in water and nickel acetate (5 min.) withstood 115 weeks' exposure before failure occurred. The two dyes with the best light-fastness were Alizarine Sapphire and Quinoline Yellow, where failure had not occurred even after four years of outdoor exposure. A slight improvement in fastness was noted with the former, due to nickel acetate sealing, but no sealant effect was shown by the latter. The dyes with the next best light-fastness were two blue dyes, Eloxan Turquoise and Aluminium Blue A. In both cases, water sealing gave higher light-fastness than nickel acetate sealing, although with the latter dye the difference was small. Study of all the values shows that sealing in nickel acetate for 30 min. instead of 5 min. did not improve the light-fastness except for the mixture of two dyes, Nigrosine and Metanil Yellow.

The results indicate that the sealant effect varies with specific dyes, that it is much more important with panels exposed outdoors than with those tested in a Fade-Ometer, and that Fade-Ometer ratings do not provide an adequate basis for selection (and in some cases even rejection) of specific dyes for use outdoors.

Outdoor Light-Fastness

Based on a study of the results from the two investigations described above, the dyes with the best light-fastness during outdoor exposure under Kingston conditions were: Quinoline Yellow Conc. 180 per cent, Alizarine Sapphire SE, Aluminium Black LLW, and Aluminium Blue A.

These dyestuffs were considered to be slightly superior to the next four, viz.: Eloxan Turquoise D-1, Alizarine Green GXN, Eloxan Red C-1, and Alizarine Red S Conc. 110 per cent.

It must be remembered, first, that the selection of the above dyes was based upon the specific experimental conditions employed and that these, as will be discussed later, have a considerable influence on the light-fastness characteristics. Further, these eight dyes were chosen from an incomplete listing of the dyes available when this work was initiated, and hence other dyes with comparable fastness characteristics may not have been included in the study. During the past few years, new dyes with, it is believed, excellent light-fastness have become commercially available. Such dyes should, however, be exposed outdoors before including them in either of the two groups of dyes listed above. Further testing of a number of these dyes is now in progress.

The above two groups include three blue and two red dyes. It is possible that the three blue dyestuffs are chemically very similar, or even identical. Efforts were made to use the colour index number of similarly coloured dyes to secure some basis of comparison. The results obtained were incomplete and, partly for this reason, not consistent. Analyses of dyes with proven satisfactory light-fastness by chemical and spectrophotometric methods would permit useful comparisons between dyes and assist recognition of changes in dyestuff composition.

Until recently, the dyes employed for colouring anodic coatings were manufactured mainly for use in the textile industry. Loss or decrease of this field of application may lead to withdrawal of a dyestuff, e.g. Alizarine Green GXN was readily secured some years ago, but it was replaced by another "equivalent" material. The substitute was recommended until commercial tests showed that its light-fastness, on anodic coatings, was greatly inferior to that of Green GXN. This is an unfortunate situation because of the heavy demand for a green dye with good light-fastness.

One theoretical objective of any colouring technique is permanence of the initial colour during exposure under service conditions. However, all colours change during exposure, although some lose colour much more slowly than others. This is true of coloured textiles, paints, porcelain enamels, and anodic coatings. In addition, during exposure outdoors, the weathering rate depends on the material and the environment, and this affects, in some cases greatly, the colour of the material.

No dyes have been found which are completely light-fast. However, many fade slowly over a long period of time and, therefore, have satisfactory light-fastness. In many cases, there is a sharp initial "break," followed by a very long period of exposure with relatively little change in appearance. Tests with such dyes for only short periods, or until a "break" occurs, will rate the light-fastness much lower than the true value. Dyes with faster fading patterns will be satisfactory only under mild service conditions, while those which lose colour at a very rapid rate should not be employed.

Reference

1 K. E. Langford; *Electroplating*, 1958, **1**, 215.

(To be concluded)

Atomic Progress—*continued from page 67*

reduced the load on fuel elements by adopting some form of individual support, and also provided some bracing.

Irradiated Magnox Cans

A magnesium alloy is used as the canning material for these fuel elements. Metallographic examination of prototype fuel elements irradiated in the Windscale piles at 100°C.[1] revealed the presence of groups of small, discrete, rounded holes, about 2-15 microns in diameter, in the grain boundaries in the can wall. Similar cavities can be produced during creep tests on magnesium alloys, and it was concluded that the cavities in the irradiated cans resulted from small changes due to distortion of the uranium. The strains involved seem to be very small, and gave about 100 cavities/cm^2 of can wall for 0·1 per cent strain at a strain rate of 10^{-5} per cent/hr. No failures occurred due to this cause. No other structural effects were found in the cans and there was no change in hardness.

Calder cans have shown similar effects, some cavities being visible in the grain boundaries of cans irradiated at the lowest temperatures.

Irradiated Fuel Elements

Eldred and his colleagues[1] state that 13 fuel elements in about 30,000 had failed or been suspected of failure. The methods of selection of faulty elements is not as easy as for Windscale elements. Radiography is successful if oxidation has changed the contour of the fuel, otherwise the cans have to be stripped off when patches of uranium oxide can be seen on the inner surface of leaking cans.

In several cases evidence of defective welds has been found, and failure attributed to this. In most cases, however, at the time of writing, no systematic explanation of the other failures could be advanced by Eldred *et al.*[1] As experience of examining both sound and faulty fuel elements accumulates, some systemization will undoubtedly be possible. Once again it must be emphasized that the vast majority of fuel elements fulfil their function satisfactorily, and considerable numbers have achieved irradiations in excess of 1,000 MWD/te without failure.

References

1 V. W. Eldred, G. B. Greenough and P. Leech; "Fuel Element Behaviour Under Irradiation." 2nd Geneva Conference Paper A/Conf. 15/P/50.

2 H. K. Hardy and H. Lawton; "The Assessment and Testing of Fuel Elements." 2nd Geneva Conference Paper A/Conf. 15/P/306.

3 A. C. Roberts and A. H. Cottrell; *Phil. Mag.*, Aug., 1956. Series 8, 1 (8), 711.

Reviews of the Month

NEW BOOKS AND THEIR AUTHORS

THERMOCHEMISTRY

"Metallurgical Thermochemistry" *(3rd Edition, 1958). By O. Kubaschewski and E. Ll. Evans. Published by Pergamon Press Ltd., 4-5 Fitzroy Square, London, W.1. Pp.* xiv + 426. *Price* 63s. 0d.

A METALLURGIST who has not at least heard of this book, first published in 1951 and extensively revised in 1955, must by now be a very *rara avis* indeed, and his species is certainly well on the way to extinction. Any praise the present reviewer could add to that already received by the authors for the previous editions would be superfluous. A measure of the value of the book and the frequency with which it is used is given by the fact that the abbreviation normally used when referring to the book has become practically a household word among metallurgists.

The book is divided into five chapters; the first covers the theoretical background of the subject, the second deals with experimental methods, and the remaining three are devoted to the estimation of thermochemical data, tables of data, and some examples of the applications of thermochemistry.

Though some previous reviewers have commented adversely on the first chapter, it remains essentially as in the second edition except for changes in detail, and it is of value mainly as a revision oriented towards practical application for those who are already familiar with thermodynamics.

The chapter on experimental methods has been brought up to date in the section on calorimetry only, perhaps because this is the field with which the authors are most familiar. For example, in the section on vapour pressure measurements, there is no mention of the use made in a number of laboratories recently of the torsion-effusion method, and in the section on e.m.f.'s, the recent development of cells using solid oxide electrolytes is not referred to. A certain unevenness of this kind is perhaps, however, inevitable.

In the fourth chapter, the tables have been revised, and in the fifth, three extra examples on the refining of iron, the solubility of alumina, and the assessment of standard values for silicon monoxide have been included. It is a pity that the table of data for dilute metallic solutions has been cut out of this edition. Though this will not trouble the many who also own the companion volume by Kubaschewski and Catterall, the table provided a useful summary for those who only had access to the one book.

In short, as the preface points out, the most important change in this edition is that the tables have been brought up to date. Those who have the second edition will probably not wish to replace it, but those who still have the first would be well advised to buy this third revised edition. One is tempted to wonder if, in the light of the forthcoming publication of a whole volume on the technique of physicochemical measurements at high temperatures and the existence of many excellent treatises on thermodynamics, Chapters I and II might not be left out of future editions. Alternatively, the last three chapters could be published separately, which would enable those who wish to obtain the revised tables of data without duplicating the other matter to do so. One notes that the price has been increased by 14·5 per cent for a 4 per cent increase in the number of pages.

J. W.T.

POINT DEFECTS

"Vacancies and Other Point Defects in Metals and Alloys." *Institute of Metals Monograph and Report Series, No.* 23. 1958. *Published by The Institute of Metals,* 17 *Belgrave Square, London, S.W.1. Pp.* 238. *Price* 40s. 0d.

ONE of the duties of the Metal Physics Committee of the Institute of Metals is to arrange Symposia and discussions on subjects of particular timeliness, from the point of view of spreading knowledge and encouraging research. The subject of point defects, linked as it is with the problems of radiation damage, has assumed considerable importance in recent years, and was chosen as the subject for a Symposium held at Harwell in December 1957. The volume under review contains the six Papers which were presented, together with a report of the general discussion which took place. The whole forms a most valuable and authoritative survey of a complex field of knowledge as it stood in 1957.

The relationship of lattice vacancies to diffusion, precipitation and creep has been established for some time; as pointed out by Dr. D. McLean, however, in his Paper on "Point Defects and the Mechanical Properties of Metals and Alloys at High Temperatures," other point defects must be considered, including foreign atoms, jogs and constrictions in dislocations, and "ledges" along grain boundaries. This Paper begins with an outline of the theories of creep in pure metals, in which the reader is made familiar not only with the climb of dislocations, held up in one slip plane, to another, and the role of lattice vacancies in this process, but also with the difficulties encountered in interpreting details. For solid solutions, the difficulties are enhanced, and the influence of solute atoms is discussed by McLean in terms of their effect on the speed of climb of dislocations. The effects of grain size and grain boundaries are discussed, and modern creep-resisting alloys receive sufficient attention to show how intimately the subject of the Symposium connects up with the practical aspects of creep. In the temperature range covered by McLean, thermal motion maintains a large and mobile population. Dr. A. H. Cottrell, in his Paper, concentrates on effects involving point defects which appear at temperatures too low for diffusion to play a significant part. The material of this Paper is less well-known to the general reader, but is just as intimately related to practical aspects of nuclear engineering as is that in Dr. McLean's Paper to creep. Dr. Cottrell deals with the hardening and embrittlement of metals and alloys due to the production of vacancies, by irradiation or quenching from high temperatures, which may then interact with, and pin, dislocations. Point defects also arise as a result of non-stoichiometry in intermetallic compounds, and as a result of cold work in metals. The latter aspect is fully discussed, with particular reference to the production and role of vacancies in fatigue processes. References to problems still awaiting solution are of much interest to the research worker, and the possibility of establishing a new mechanism for hardening metals is intriguing.

Dr. P. L. Pratt contributes a comprehensive review of the connection between point defects and mechanical properties in ionic crystals, where information about defect density can be obtained from electrical conductivity measurements. The theoretical and experimental work reviewed shows that annealed ionic crystals may contain a high density of pairs or clusters of vacancies, which is increased by deformation beyond the limit of easy glide. Such vacancy pairs or clusters may pin dislocations, as in metals, and in general the basic features concerning point defects and mechanical properties in ionic crystals and metals are closely similar. Dr. Pratt, however, includes a timely warning that electrostatic interactions, due to the ionic nature of the crystals he discusses, prevent too close a comparison.

The influence of point defects on the physical properties of metals is described in the Paper by Dr. T. Broom and Dr. R. K. Ham. The Paper outlines the ways of studying defects by investigating energies of formation under equilibrium conditions and by calorimetric experiments on stored energy in samples with a vacancy supersaturation. In describing the effects of defects on electrical conductivity, density, lattice spacing,

and other properties, stress is rightly laid on the difficulties and uncertainties which complicate interpretations.

Diffusion is the main concern of Dr. W. M. Lomer's Paper; proposed mechanisms in both random and ordered alloys, and the effects of non-equilibrium concentrations of vacancies, are discussed; the more complex cases of diffusion under concentration gradients are included, and there is an interesting section on the important, but as yet poorly understood, effects due to diffusion "short circuits" produced by grain boundaries or substructures.

The sixth Paper, by P. C. Williams and P. C. S. Hayfield, gives theoretical and experimental evidence that the surface layers of a crystal contain a higher density of vacancies and point defects than the interior. The consequences of this are discussed, with particular reference to oxidation and corrosion.

This discussion occupies some thirty-five pages; about half of it came from members of British universities, nearly one-third of it from U.K.A.E.A., and it includes contributions from the U.S.A. and France. It is of commendable relevance. The fact that out of a large audience, only 21 people, apart from authors of Papers, could find anything to discuss, is an indication that the subject is not well known, that a lot of people want to know more about it, and possibly that people found it difficult, on the spot, to take in details sufficiently well to discuss them there and then. There are thus three powerful arguments for the purchase of this book, which is adequately indexed, attractive in make-up, and excellent value.

G. V. R

VACUUM TECHNIQUES

"Fourth National Symposium on Vacuum Technology Transactions." *Edited by Wilfred G. Matheson. Published by Pergamon Press, 4-5 Fitzroy Square, London, W.1, and New York, for the American Vacuum Society Inc. Pp. 176. Price 90s. 0d.*

TWENTY-EIGHT Papers presented at the fourth annual meeting of the American Vacuum Society, successor to the Committee on Vacuum Techniques, are collected in this volume. Together, they cover a wide range—from fundamental study and application of vacuum technique in pure and applied research to industrial methods and applications. Whilst most of the authors are American, there is a British collaboration in a Paper on a new diffusion pump fluid, and Papers from Germany and Japan are also included. Brief discussion following a few of the Papers is given.

Papers on pumping equipment include several dealing with problems encountered in achieving ultimate vacua below 10^{-6} mm. mercury. A new silicone fluid is described by which, it is claimed, improved ultimate vacua can be obtained even with pumps of poor self-purifying facility. Description is also given of studies leading to improved design in the Leybold range of oil diffusion pumps, by which vacua below 10^{-7} mm. mercury can be achieved. Details of an all-metal system incorporating a liquid nitrogen trap, and characteristics of a Leybold ion-getter pump, both for operation in the ultra high vacuum range, are given.

The Roots blower-oil sealed rotary pump combination was dealt with in detail in an earlier Symposium in the series, but with emphasis on blower performance. In the present volume, the role of the backing pump is discussed, and a method described for predicting the speed/pressure curve of the combination from known characteristics of the components. Steam ejector pumps are also discussed, and typical installations on consumable electrode melting furnaces, and for stream degassing, are described. It is of interest that recent developments on this type of pump have extended ultimate vacuum to below 10^{-2} mm. mercury for pumping speeds higher than 200,000 ft^3/min.

Much information is included on methods of preparation and on properties of vacuum-deposited metal films. This is of interest both from the viewpoint of industrial application and from that of experimental physics, in which large clean metal areas are frequently required in the study of surface properties. Both aspects are considered, industrial application being related mainly to metallization of plastics.

Some twenty-five pages are devoted to discussion of metallurgical applications other than metallizing. Vacuum degassing processes and melting *in vacuo*, both by induction heating and by the consumable electrode arc technique, are described and broadly assessed. Application of the vacuum stream degassing technique in the American iron and steel industry is dealt with in a short Paper, and although not much detail is given, approximate operating costs indicate that this process may have significant economic advantage over the induction and consumable electrode techniques for refinement of steel.

A review is given of the evolution of vacuum heat-treatment practice, and details are included of recently-built cold retort furnaces in which heating elements are located inside the vacuum chamber, thermal insulation being provided only by metallic radiation shields. Such furnaces, it is claimed, have lower thermal inertia, and hence shorter heating and cooling times, than systems in which the evacuated retort is heated in a conventional batch furnace. Somewhat disappointingly, there is no reference to progress in development of continuous vacuum furnaces.

Difficulties in programming a Symposium of this type are well known; selection has to be made, and it is almost inevitable that some aspects of the subject matter receive fuller treatment than others. For example, in the present volume one feels that instrumentation could have been better represented, the only item of note being a new halogen leak detector. Again, vacuum distillation is not mentioned. On the other hand, there is little, if any, overlapping, and the Papers, on the whole, are detailed and informative. In general, the volume maintains the standard achieved in earlier publications of the series in providing an up-to-date review of development in vacuum technology.

D. T. F.

Obituary

Sir Claude Gibb

WE regret to record the death of Sir Claude Dixon Gibb, chairman and managing director of C. A. Parsons and Co. and until last year chairman of A. Reyrolle and Co.

He was also chairman of the Nuclear Power Plant Company and Anglo Great Lakes Corporation.

Australian by birth, Sir Claude was educated at the South Australian School of Mines and Adelaide University. From 1920 to 1923 he was senior research assistant in the engineering laboratory of the University of Adelaide.

In 1924 he came to Britain as a student apprentice, joining C. A. Parsons at Newcastle. He stayed with the company until he became chairman and managing director in 1945.

During the second World War he held a number of important posts in the Ministry of Supply, eventually becoming chairman of the Tank Board in 1944. It was in 1946 that Sir Claude established a nuclear research department at C. A. Parsons, and this grew until, in 1955, the company joined in the formation of the Nuclear Power Plant Company.

Sir Claude's death occurred four days before the Institute of Mechanical Engineers was due to announce the award of the 1959 James Watt International Medal to him.

Design of Die-Castings

IN the article "Design of Die-Castings," which appeared in our issue of 2 January, the third column of Table I, on page 8, referred to maximum thickness of large areas. This should have read minimum thickness.

Industrial News *Home and Overseas*

Inert Gas Production

News from **Birlec Limited** is to the effect that the Dryer and Gas Plant Division of that company is at present engaged in designing an inert gas generator with a capacity of 200,000 ft^3/hr. In the design, air mixed with propane is deliberately ignited within an enclosed cylinder, and the inert gases generated by the combustion are collected and employed in the purging process.

Development work on inert gas generator design is at present being carried out by the company to establish the optimum sizes of burner for a wide range of generator capacities.

Powder Metallurgy

A postponement of the next meeting of the Powder Metallurgy Joint Group of the Iron and Steel Institute and the Institute of Metals has been announced. This meeting will now be held on Wednesday, April 29 next, and not on March 12, as previously announced.

The meeting will consist of the presentation and discussion of a series of Papers on "Theoretical Aspects of Sintering," and will be held at Church House, Great Smith Street, Westminster, London, S.W., commencing at 9.30 a.m. On the evening of the meeting there will be an informal conversazione at the headquarters of the Institute of Metals, 17 Belgrave Square, London, S.W.1.

A London Trade Exhibition

We are advised that a private trade show for the "Norton" hydraulic press and "Crown-Permag" chucks has been organized by **Frank Lewis and Co. (London) Ltd.,** and will be held at the Hammersmith Town Hall, London, W., from February 23 to 27 inclusive.

At this display, the "Norton" 7½ ton hydraulic press, which is manufactured by The Norton Tool Company Ltd., will be demonstrated, together with examples of the tooling service which this company is providing for these machines in conjunction with the firm of A. Capp and Sons Ltd. A range of hydraulic pumps, control gear and power cabinets will also be shown.

The full range of "Crown Permag" chucks, both rectangular and circular, will also be exhibited, and one of these will be shown on a surface grinder to demonstrate the stability and high magnetic power which are features of this range of chucks. Readers who may wish to attend this exhibition may secure invitations from Frank Lewis and Company at 65 St. Paul's Churchyard, London, E.C.4.

A Birmingham Event

An annual event in Birmingham is the Conversazione and Festival of the Arts and Sciences organized by the **Birmingham and Midland Institute,** which was held last week in the rooms of the Institute. The whole event consists of entertainment, exhibitions, and dancing.

Of particular interest to industrial and technical visitors was the exhibition, which consisted of examples from a range of industries, arts and crafts. In the industrial section, exhibitions were arranged by the following concerns:—**Pyrotenax Ltd.** (mineral insulated metal sheathed cables); **The Mond Nickel Company Ltd.** (magnetostriction); **Joseph Lucas Ltd.** (modern welding and brazing techniques); **Imperial Chemical Industries Ltd.** (problems of corrosion); **Johnson, Matthey and Co. Ltd.** (investment casting, lost wax process); and **Radio Heaters Ltd.** (high frequency heating).

Plastics Finish on Metal

Recently installed by the **Darlaston Galvanised Holloware Company Ltd.** is a plant capable of bonding many polythene and other types of plastics to ferrous or non-ferrous metal by the Plasinter Process. This new technique, which it is claimed, completely overcomes peeling, is said to have many applications in engineering, agricultural and marine industries, and also to be particularly suitable for wire work, tubular steel assemblies, sheet metals, aluminium ware, brackets, castings, etc.

The new treatment is stated to protect the metals coated from corrosion; they are then non-toxic, and the coatings themselves will withstand sterilization in boiling water. Of particular interest is the statement made by the manufacturers that "in this process many of the inherent disadvantages associated with homogeneous polythene articles, such as porosity and induction of static electricity, have been overcome to a high degree." Where required, the coatings can be supplied in many bright colours. A special division has been created by the company to deal with this process, and will be known as the Plasinter Division.

Annealing Equipment

Delivery has just begun of more than half-a-million pounds' worth of annealing equipment for the new steelworks of Sociedad Mixta Siderurgia Argentina, at San Nicolás, near Rosario, Argentina. All the furnaces for the annealing shop, which is over 350 ft. long and 100 ft. wide, are being supplied by the **Incandescent Heat Company Limited,** as packaged units, completely assembled in England and shipped ready for immediate operation in Argentina.

The plant will anneal more than 300,000 tons of steel annually, and the complete order will be shipped by the middle of this present year.

New Instrument Laboratory

Construction has commenced of the new research laboratory which the **Cambridge Instrument Company Ltd** is building at Cambridge. Overlooking the river Cam, the new building is within ten minutes' walk of the centre of the town. The top floor will be used for the design and drawing offices, and the three floors below are to be fitted with the latest equipment for instrument work involving physics, chemistry, electronics, and precision mechanical engineering. The new building is scheduled for completion by June next.

The company also announces that their London showrooms, at 13 Grosvenor Place, S.W.1, have now been completely redesigned and redecorated in modern style. The instruments shown are the latest models, mounted on well-designed, easily accessible fixtures and showcases.

Canadian Statistics

News from Ottawa is that the Dominion Bureau of Statistics reports that production of new primary copper in all forms (recoverable copper content of Canadian ores) during October, 1958, amounted to 22,560 tons, compared with 27,546 tons in the previous month and with 31,756 tons in October, 1957.

Production of nickel in all forms in October, 1958, amounted to 3,649 tons, compared with 11,786 tons in the previous month, and with 15,332 tons in October, 1957.

Smaller quantities of zinc and silver were produced in October than in the same month of 1957, but lead output was larger. October totals: silver, 2,390,012 fine ounces (2,853,815 a year earlier); lead, 14,564 tons (14,294); and zinc, 27,028 tons (36,782). January-October totals: silver, 25,526,348 fine ounces (23,645,060); lead, 150,167 tons (150,176); and zinc, 346,126 tons (338,794).

Government Aid to Business

Readers will have seen on page 61 of this issue of Metal Industry the leading article dealing with the help which the Government can now offer to businesses setting up or expanding in places where unemployment is high. Full details of how this aid can be secured may be obtained from The Secretary, Development Areas Treasury Advisory Committee, Treasury Chambers, Great George Street, London, S.W.1.

In the case of firms interested in Northern Ireland, application for details should be made to the Ministry of Commerce, Chichester House, Chichester Street, Belfast.

Malayan Tin Shipments

Statistics issued in Singapore show that tin shipments from that port in the first half of the current month amounted to 31¼ tons. This compares with 13¼ tons shipped in the first half of December last year. First-half January shipments were as follows: Japan 5 tons, Pacific 20½, and the Middle East 6¼ tons; all others nil.

Shipments from Penang during the period under review totalled 1,467¾ tons, compared with 674¾ tons in the first half of December. They were as follows: United States 710 tons, Europe 197, Japan 190, India 95¼, South America 30, Africa 13, Australasia 81, and the Middle East 151½; the rest nil.

Industrial Safety

One of the latest additions to the range of equipment for industrial safety purposes is the "Starlight" eye protection shield (No. 131), which weighs under ¾ oz. This shield is designed to give maximum ventilation, avoiding steaming-up, is non-inflammable, has an extra wide screen, and can also be worn over spectacles. It has a strong non-corrosive metal frame with a bright nickel finish.

This eye shield is a product of the

London firm of **Randolph Supply Co.,** which is also responsible for a number of other optical products and safety goggles.

Enquiry from Italy

It is reported by the Board of Trade that the British Consulate-General at Milan have been approached by the firm of ZETA-BI, of Via Colombo, 11, Genoa, who wish to enter into business relations, either as representatives or as importers on their own account, with U.K. manufacturers of the following materials:—

(a) Low temperature soldering alloys (of a silver base); (b) medium temperature soldering alloys (of a copper base); (c) soldering alloys of aluminium base; (d) soldering alloys of tin and lead bases for radio and electro-technical industries; (e) appropriate fluxes for the above; (f) special nickel based electrodes for stainless steel, grey castings, and special high-resisting steels; (g) special electrodes for bronze (bronze arc).

Manufacturers interested in this enquiry should write direct to the Italian concern.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange warehouses fell by 326 tons, and were distributed as follows at the end of last week: London 5,985 tons, Liverpool 7,710 tons, and Hull 1,430 tons.

Stocks of refined copper were distributed as follows: London 2,325 tons, Liverpool 1,746 tons, Birmingham 329 tons, and Manchester 250 tons.

New Guinea Nickel

According to recent news from The Hague, nickel and cobalt ore reserves in Dutch New Guinea are estimated at between 100 and 200 million tons by the Dutch Overseas Affairs Minister, Mr. G. P. Helders. The Minister told a press conference that there was great foreign interest in the exploitation of these reserves. The Government was now waiting for a decision by some large enterprises who were considering a venture together with Dutch capital. He said geological exploration in the area had also disclosed the presence of chrome and iron ore. So far, only Dutch capital had been invested in Dutch New Guinea, except in the oil industry.

Technique of Pneumatics

A sales conference was held in London last week by **Martonair Limited,** and was attended by over twenty technical sales representatives from the United Kingdom and by several other members of the sales staff. New developments in the technique of pneumatics were discussed and advance information circulated.

Tin Agreement with Russia

It has been reported from Paris that agreement has been reached between Russia and the International Tin Council on global exports for 1959, and an official announcement is expected in the next few days. Usually well-informed quarters believe that agreement has been secured on the basis of a total export figure between the 12,000 tons mentioned in trade quarters and the estimated 15,000-16,000 tons shipped in 1958.

Acceptance of a ceiling is said to have been conditioned by Russia on freedom to sell to any country. This would imply that an assurance has been received of an early removal of import restrictions from those countries operating quotas on Russian tin. These include France, United Kingdom, Netherlands and Denmark.

In London, the International Tin Council had no comment to make at this stage.

Surinam Aluminium

Engineering surveys have begun for the $150,000,000 hydro-electric power project that the Aluminum Company of America and the Surinam Government are to build in the Brokopondo area, 80 miles north of the port of Paramariho. Construction of the project, which will include a dam, a 150,000 kilowatt power plant and a transmission line, is scheduled to begin by next year. The power will be adequate to supply a new Alcoa aluminium smelter of 60,000 tons annual capacity.

Completion of the power project is scheduled for 1965, and Alcoa expects to have the new smelter in operation near its bauxite-mining centre at Paranam by then. Meanwhile, exports of bauxite by the Surinam Aluminium Company last year declined by 10 per cent to some 2·34 million tons, and were about 20 per cent lower than the results recorded in 1956.

Translations Bulletin

A new publication under the title of "The L.L.U. Translations Bulletin" has been introduced by the Department of Scientific and Industrial Research's Lending Library unit. The aim of this publication is to provide British scientists and engineers, who are anxious to have details of current U.S.S.R. research, with up-to-date information on the availability of Russian translations.

The "Bulletin" contains lists of books, journals, and other scientific Papers which are now available, or which are being translated and will become available in the near future. It will also contain articles on new scientific developments in Russia. These can be followed up in detail with the aid of L.L.U.'s comprehensive collection of Russian scientific literature. It is contemplated that this new publication will, in the future, cover other language translations.

Rhodesian Copper

Copper production in the Rhodesian Selection Trust group of mines is expected to be around 10,000 tons short of the curtailed target in the present year, ending June 30, 1959. Sir Ronald Prain, chairman, gave this news at an informal meeting of the companies in London last week. The shortfall in production is entirely attributable to the fifty-two day strike which ended on November 5. Production at Roan Antelope, he said, might not much exceed 77,500 tons, at Mufulira about 86,000 tons, and at the Chibuluma property something over 18,000 tons. Target production on the curtailed basis was 80,000 for Roan and 93,000 for Mufulira.

Sir Ronald considered the opening of the copper refinery at Ndola as an "important development brought about by the exacting technology of the modern world, which demands a final product of ever-increasing purity and performance. The refinery does not necessarily represent any greater profit to Roan Antelope, but ensures that whatever happens at the mine or overseas they will be able to produce economically a copper of the highest possible quality for the markets of the world in the future."

He added: "We have experienced difficult conditions in the copper industry this year, and face you with a background of the poorest results in many years. But mining is a long-term business, and the health of the industry should not be examined on the basis of any one year's results."

Following his statement, Sir Ronald Prain took several questions from the floor. With regard to competitive substitutes, he said the industry had new and challenging problems to meet and overcome, but at current prices there was little to fear from the substitution of other materials such as aluminium and plastics. It had been noted that substitutes came into play at certain price levels for certain uses. On the disposal of the British Government's copper stockpile, he said he personally did not like Government stocks, except for strategic purposes when they were not likely to be returned to the market. The end of Government selling would be a relief, and as the disposal was spread over the year, it was unlikely to affect the market and gave no cause for alarm.

U.S. Credit for Copper

Reports from Washington state that the United States Export-Import Bank has granted supplementary credits of 15 million dollars to the Southern Peru Copper Corporation. Last year the Bank lent the Corporation 100 million dollars to mine the Toquepala copper deposit in the Peruvian Andes. The Bank said the new credits would help in meeting an over-run in total costs brought about by inflationary trends, certain changes in construction plans, and additional construction costs not entirely anticipated before work began three years ago.

Development of the Toquepala deposit calls for investment now estimated at 230,000,000 dollars. It has passed the half-way mark, and the first shipments of copper from the port of Ilo are expected to be made late this year or early in 1960. The project called for the construction of 131 miles of railroads, the construction of an ore-crushing mill, and a concentrating plant at the mine with a daily capacity of 30,000 tons of ore, and the erection of a modern smelter near the port of Ilo to process some 1,250 tons of concentrates per day, giving an output of 400 tons of copper daily. It also provided for the construction of a 44,000 kW power plant at the smelter.

Metal Finishing

On Friday next week (January 30), a meeting of the Sheffield and North-East branch of the **Institute of Metal Finishing** will be held at the Grand Hotel, Sheffield, at 7 p.m. On this occasion the speaker will be Dr. J. M. Sprague, who will take as his subject "Some Recent Developments in Cyanide Plating."

Dry Lubrication

Details have been distributed of Moly-Vapour Bond, described as a new method of dry lubrication. This product is marketed by **K. S. Paul (Molybdenum Disulphide) Ltd.,** and is put up in 12 oz. containers with internal agitator. The producers list a wide range of typical uses for this lubricant, including that of a parting agent for moulding machines,

dies, die-casting machines, etc., also for dry lubrication of tightly fitting parts, instrument bearings requiring lowest coefficient of friction, slideways, cams, gears, and threads.

Eventually the company hopes to market these tins through the trade, but in the meantime they are available ex stock from their headquarters at the Great Western Trading Estate, Park Royal Road, London, N.W.10.

A North-Eastern Meeting

Members of the **North East Metallurgical Society** will meet on Tuesday next, January 27, at the Cleveland Scientific and Technical Institution, Middlesbrough, at 7.15 p.m., to hear Mr. G. Goddard, M.Eng., F.I.M., on the subject of "Some Characteristics of High Strength Aluminium Alloys."

Trade with Bolivia

A copy of the new Bolivian Customs Tariff, which came into effect on December 1 last year, has now been received by the Board of Trade. In general, goods are now subject to both specific and *ad valorem* duties, as compared with the *ad valorem* duty only levied under the former tariff. In most cases, however, it is understood the *ad valorem* duties are lower than before.

The "services rendered" tax for goods cleared through the Bolivian Customs within 30 days has been increased from 1 per cent to 2 per cent of the c.i.f. value, with corresponding increases in respect of goods not cleared within 30 days. Details of the new tariff rates may be obtained from the Export Services Branch of the Board of Trade, Room 729, Lacon House, Theobalds Road, London, W.C.1.

Luncheon Club Meeting

Members of the **Finishing Luncheon Club** are holding their next meeting on Thursday, February 19 next, at the Rembrandt Hotel, London, W., at 1 p.m., when their guest speaker will be Mr. K. G. Jones, general manager of the Vitreous Enamel Development Council.

Cuban Aluminium Plant

News reaches us via New York to the effect that Mr. Victor Muscat, who heads Victor Industries Corporation, has announced that he has proposed to the new Cuban Government to build a two-million-dollar plant for the production of aluminium containers and aluminium construction materials. Mr. Muscat said the project would complement Victor's factories in other countries.

Machine Tools Import Duty

Notice has been given by the Board of Trade that they are considering an application regarding the charging of import duty on the following goods:—Machine tools for working metal or metallic carbides falling within heading 84.45 of the Customs and Excise Tariff of the United Kingdom, other than flying shears and strip coilers of a kind used in rolling mills.

The application is for the discontinuance of exemption of particular importations by duty free directions under Section 6 of the Import Duties Act, 1958, and for a reduction in the rate of import duty.

A statement of the applicants' case will be made available to all firms and organizations with a bona fide interest who wish to make representations in the matter, if they are prepared to give an undertaking to treat the information contained therein as strictly confidential, and to allow their comments to be passed to the applicant for reply. Requests for a statement of the case, together with an undertaking in the terms set out above, should be addressed in writing to the Board of Trade, Tariff Division, Horse Guards Avenue, London, S.W.1, not later than February 20, 1959.

Aluminium in France

Pechiney, France's leading aluminium producer, announced earlier this week that in 1958 its output rose to 139,000 tons—7,000 tons more than in 1957. Output in 1959 was scheduled to reach 142,000 tons and then increase quickly, thanks to the new plant at Nogueres, in South-Western France, which would use gas power supplied by the natural gas field of Lacq. Because of this plant, Pechiney's aluminium output was expected to reach 192,000 tons by 1961.

Pechiney's Metropolitan aluminium output was to be added to the company's share in "Alucam"—the Cameroons aluminium plant formed together with Ugine, France's second aluminium producer. Pechiney's Alucam share was 23,000 tons in 1958, and is expected to be about 32,000 tons this year.

Treasury Consent for B.A.

It was announced in the House of Commons on Tuesday last by the Financial Secretary to the Treasury that the Treasury has given its consent to the acquisition of the majority holding in British Aluminium Company Limited by Reynolds-T.I. Aluminium, on the understanding that control of British Aluminium remains in this country.

In making this announcement, the Financial Secretary said that the arrangements between Tube Investments and Reynolds Metals "ensure that control of the British Aluminium Company remains in U.K. hands" and that "these arrangements will not be modified without consent of the Treasury."

Aluminium in Electrical Engineering

Appearing for the first time at the Electrical Engineers (A.S.E.E.) Exhibition, which is being held this year in March next at Earls Court, **Northern Aluminium Company Limited** will have a stand showing a wide range of the uses of aluminium in the field of electrical engineering. A feature is also made of the development work the company is doing in collaboration with the electrical industry, supported by the extensive research facilities of the Aluminium Limited group, of which Northern Aluminium is a member.

Chief among the exhibits are Noral aluminium transmission and distribution line fittings, which are displayed together with tools and general accessories. Prominence will also be given to a display of Noral aluminium and aluminium alloy busbars in rectangular, tubular and channel shapes, and to accessories for use with them.

The ease of fabricating aluminium will be further illustrated by a range of welded components at present being made for the electrical industry from Noral sheet and extrusions, and a notable new product will be "Noralduct" roll-bonded sheet, which has passageways integral with it. Originally developed for refrigerator evaporators, it has wide application for heat exchangers, and transformer radiators and radio chassis are amongst the items to be shown.

Commercial Travellers' Schools

Readers interested in the Royal Commercial Travellers' Schools are advised that the Festival Dinner will be held on March 20 next, at the Trocadero Restaurant, London, W.1, and Associations' Day at the Schools will be on June 20 this year.

Forthcoming Meetings

January 27 — North East Metallurgical Society. Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough. "Some Characteristics of High Strength Aluminium Alloys." G. Goddard. 7.15 p.m.

January 28—Institution of Production Engineers. Shrewsbury Section. Shrewsbury Technical College, Abbey Foregate, Shrewsbury. "Impact Extrusion and Cold Flow Pressing of Ferrous and Non-Ferrous Metals." H. W. Byles. 7.30 p.m.

January 29—Institution of Production Engineers. Lincoln Section. Ruston Club, Lincoln. "Designing for Production." A. P. Peat. 7.30 p.m.

January 30—Institute of Metal Finishing. Sheffield and North-East Branch. Grand Hotel, Cavendish Room, Sheffield. "Some Recent Developments in Cyanide Plating." Dr. J. M. Sprague. 7 p.m.

Metal Market News

THE December copper statistics, published last Thursday, acted as something of a cold douche on the London Standard Market, which staged rather a collapse at midday. In terms of short tons of 2,000 lb., the details are as follows:—Inside the United States, production of crude copper amounted to 105,340 tons, nearly 8,000 below November, while the output of refined was 146,979 tons, compared with 128,048 tons in the previous month. Deliveries of refined copper to consumers dropped from 131,188 tons to 116,310 tons, and stocks at 80,722 tons were fully 13,000 tons below the end of November figure. Outside the United States, however, stocks rose from 135,167 tons at November 30 to 178,152 tons at the end of December, so that on balance world stocks were up by about 30,000 tons. Production was also up, crude from 132,527 tons to 156,853 tons, while refined output rose from 102,061 tons in November to 135,213 tons in December. Deliveries followed a similar pattern, and advanced from 129,909 tons to 144,531 tons. From £231 10s. 0d. on Wednesday, the settlement price dropped on Thursday to £229 5s. 0d., with the Kerb about 15s. lower, for the market was a good deal disappointed, having believed that once again there would be a nett reduction. At 80,000 tons, however, stocks in the U.S.A. are equal to much less than one month's cover, which is certainly not a lot. Elsewhere, the position was a good deal more comfortable, as shown above. It would really seem that initially the standard market took fright over the December statistics, but on reflection they were deemed to be not so bad, and by the end of the week cash had recovered to £232 and three months to £228. There was a turnover of 15,025 tons, apart from Kerb trading, which on some days was very active, cash gaining £6 and three months £3 10s. 0d., the backwardation going out from 30s. to £4.

Copper was very active last week, and the turnover averaged 3,000 tons daily. At the beginning of the week, L.M.E. warehouse stocks were reported 575 tons down at 4,696 tons, which is the lowest level seen for a long time past. As we write, the figures for this week are not to hand and the trend is a matter of guesswork, but in certain directions there is a disposition to look for some improvement. As to the backwardation, this may well get wider as a result of further advances in the cash price, for it is bound to take time to strengthen the stock position. The present situation is not good from the point of view of those who wish to hedge, and it is to be hoped that matters will improve before long. Last week saw an advance of 50 points in the custom smelters' quotation to 29½ cents, a movement which reflected the firmness of the London market. On Thursday, when the quotation sagged on profit taking, this advance was put in question by rumours that the ground gained, or some of it, at any rate, might be lost again. However, the week ended on a firm note, and although business is not reported as very brisk, the general opinion seems to be that the settlement price will remain at £230 or above.

The other metals were reasonably steady, but lead lost some ground and the value of zinc is now firmly established above the price of lead. In zinc, the turnover was some 5,450 tons, January finishing 5s. down at £76 while April was 5s. higher at £74. In lead, about 5,675 tons changed hands, with a drop of 12s. 6d. for prompt to £72 and a loss of 10s. in April at £72 5s. 0d. Tin was rather quiet, with a turnover of only 665 tons, the close being £760 cash and three months. These quotations showed an increase on the week of £3 in cash and of 30s. in the three months' position. Business in old metals has, on the whole, been quiet and the holiday influence still prevails.

New York

Copper futures have moved in a narrow range, and after a slight gain fell back latterly to close about unchanged from the previous close. Dealings were slow; custom smelters reported light sales. Some sources indicated that the custom smelter price could go lower if the scrap price falls. However, the scrap price was steady, and the belief is that any steadiness in the London Metal Exchange will keep scrap copper steady. Intake of scrap was fair. Meanwhile, producer sources indicated a good first quarter, with one leading source predicting a tight first quarter for copper. Tin was firmer in modest business. Lead and zinc were modestly active.

Sales of metal cans in the United States during the first 11 months of 1958 were 3·4 per cent ahead of the corresponding 1957 period, the Can Manufacturers' Institute has reported. It said November shipments exceeded those of a year earlier by 12·9 per cent, and that preliminary figures indicated a continued high output for December.

The Office of Civil and Defense Mobilization has issued a new regulation which broadens its authority to restrict any imports whose volume "imperils national security." Fresh demands for tariff protection from domestic industry are expected to follow. Applications have been accepted in advance from the cobalt, tungsten, fluorspar, and heavy electrical industries.

A clause in the Trade Agreements Extension Act of last year compels the O.C.D.M. to start an investigation at the request of any interested party or the head of any government agency. Industries and individuals, however, have not been able to invoke the law until the O.C.D.M. issued procedures. The new order requires the O.C.D.M. director to make recommendations to the President if investigation convinces the director that there is a threat of impairment of national security. If the President concurs, he must introduce tariff increases, import quotas, or other relief measures.

The U.S. Commerce Department has clamped restrictions on metal scrap imports sold as surplus by the United States Government overseas. Beginning February 15, such scrap may be imported only if it would relieve domestic shortages or otherwise benefit the economy. Surplus metal scrap is at present exempt from this provision. The ruling on scrap was part of a broad order governing imports of all non-agricultural Government surplus property sold abroad. The revised order spells out in greater detail the rules for deciding which surpluses may be imported.

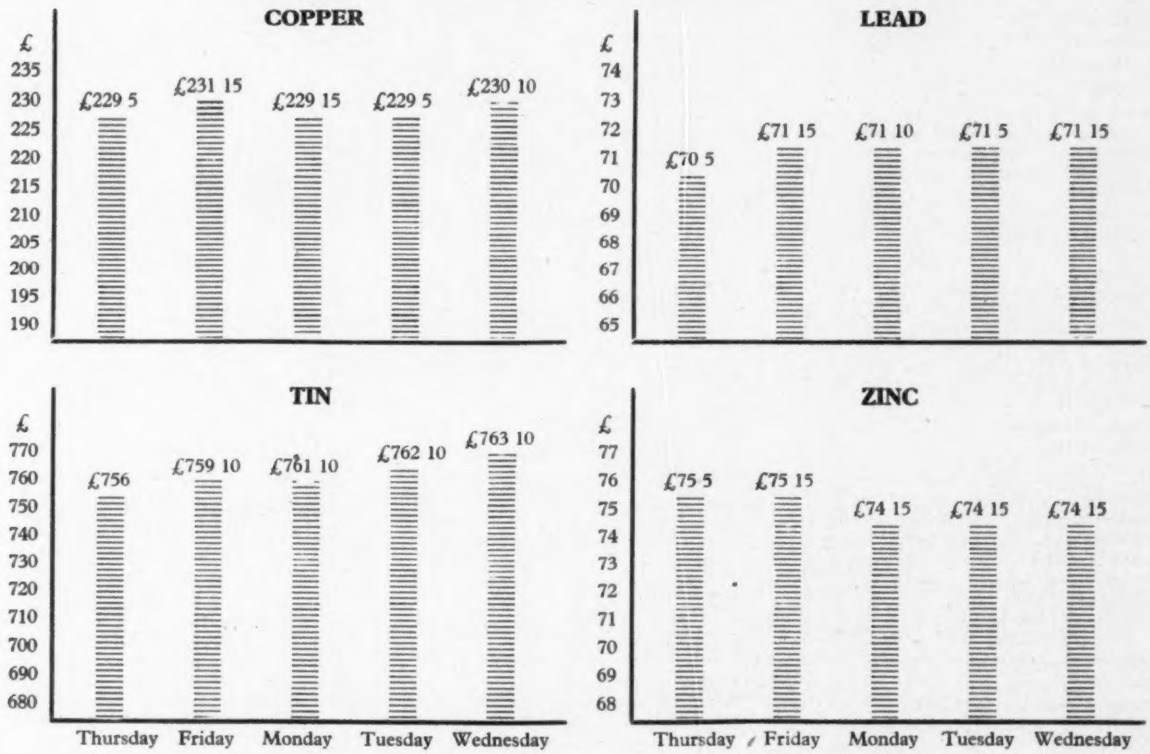
Birmingham

Outlook for non-ferrous metals in the Midland area is uncertain. So far this year there has been no indication of any substantial improvement in the placing of contracts. Buyers of raw materials are very cautious and are not ordering new supplies until stocks are right down. Demand for metal fittings for the motor trade is a bright spot in an otherwise dull market, and there is every indication that this class of business will continue. The cycle trade, on the other hand, is suffering from recession, and workers have been declared redundant or put on short time until conditions improve. Amongst the electrical equipment firms there is a brisk trade in gear which is destined for new power stations in this country and overseas.

No new feature emerges in the iron and steel industry except for rather more activity amongst makers of castings used in domestic gas and electric boilers, cookers, etc. Pig iron output continues at the low stage reached at the end of last year, but even so supplies are ample for local foundries. One of the big machine tool firms in the area has recently put some of its workers on short time. Like other firms in that industry, it has suffered a sharp decline in orders. Contracts for structural steel are scarce, and mills rolling heavy joists and sections could handle much more work. There is a moderate amount of business in heavy iron castings for the engineering industries. Makers of heavy plates have sufficient orders to ensure steady employment.

METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 15 January to Wednesday 21 January 1959



OVERSEAS PRICES

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg	≏£/ton	Canada c/lb	≏£/ton	France fr/kg	≏£/ton	Italy lire/kg	≏£/ton	Switzerland fr/kg	≏£/ton	United States c/lb	≏£/ton
Aluminium			22.50	185 17 6	210	157 10	375	221 5	2.50	212 10	26.80	214 10
Antimony 99.0					220	165 0	445	262 10			29.00	232 0
Cadmium					1,350	1,012 10					145.00	1,160 0
Copper												
Crude												
Wire bars 99.9							440	259 12 6				
Electrolytic	32.00	235 10	28.00	231 5	320	240 0			2.95	250 15	29.00	232 0
Lead			11.50	95 0	104	78 0	174	102 12 6	.90	76 10	13.00	104 0
Magnesium												
Nickel			70.00	578 5	900	675 0	1,300	767 0	7.50	637 10	74.00	592 0
Tin	107.75	793 0			1,088	816 0	1,450	855 10	9.00	765 0	99.37	795 0
Zinc												
Prime western			11.75	97 0 0							11.50	92 0
High grade 99.95			12.35	102 0 0								
High grade 99.99			12.75	105 7 6								
Thermic					112.00	84 0						
Electrolytic					120.00	90 0	176	103 17 6	.91	77 7 6	12.75	102 0

NON-FERROUS METAL PRICES

(All prices quoted are those available at 2 p.m. 21/1/59)

PRIMARY METALS

		£	s.	d.
Aluminium Ingots....	ton	180	0	0
Antimony 99·6%	,,	197	0	0
Antimony Metal 99%..	,,	190	0	0
Antimony Oxide......	,,	180	0	0
Antimony Sulphide Lump..............	,,	190	0	0
Antimony Sulphide Black Powder........	,,	205	0	0
Arsenic..............	,,	400	0	0
Bismuth 99·95%......	lb.		16	0
Cadmium 99·9%	,,		9	6
Calcium	,,	2	0	0
Cerium 99%	,,	16	0	0
Chromium	,,		6	11
Cobalt	,,		16	0
Columbite.... per unit			—	
Copper H.C. Electro..	ton	230	10	0
Fire Refined 99·70%	,,	229	0	0
Fire Refined 99·50%	,,	228	0	0
Copper Sulphate	,,	74	0	0
Germanium	grm.		—	
Gold	oz.	12	10	0¼
Indium	,,		10	0
Iridium..............	,,	20	0	0
Lanthanum	grm.		15	0
Lead English..........	ton	71	15	0
Magnesium Ingots....	lb.		2	3
Notched Bar	,,		2	9½
Powder Grade 4......	,,		6	3
Alloy Ingot, A8 or AZ91	,,		2	8
Manganese Metal....	ton	290	0	0
Mercury	flask	74	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	,,		5	6
Osmium	oz.		nom.	
Osmiridium	,,		nom.	
Palladium	,,	5	15	0
Platinum	,,	19	10	0
Rhodium	,,	40	0	0
Ruthenium	,,	15	0	0
Selenium	lb.		nom.	
Silicon 98%..........	ton		nom.	
Silver Spot Bars......	oz.		6	4¼
Tellurium	lb.		15	0
Tin..................	ton	763	10	0
***Zinc**				
Electrolytic..........	ton		—	
Min 99·99%	,,		—	
Virgin Min 98%	,,	74	1	10½
Dust 95/97%........	,,	109	0	0
Dust 98/99%........	,,	115	0	0
Granulated 99+% ..	,,	99	1	10½
Granulated 99·99+%	,,	112	16	3

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	,,	202	0	0
B.S. 1490 L.M.7	,,	216	0	0
B.S. 1490 L.M.8	,,	203	0	0
B.S. 1490 L.M.9	,,	203	0	0
B.S. 1490 L.M.10....	,,	221	0	0
B.S. 1490 L.M.11....	,,	215	0	0
B.S. 1490 L.M.12....	,,	223	0	0
B.S. 1490 L.M.13....	,,	216	0	0
B.S. 1490 L.M.14....	,,	224	0	0
B.S. 1490 L.M.15....	,,	210	0	0
B.S. 1490 L.M.16....	,,	206	0	0
B.S. 1490 L.M.18....	,,	203	0	0
B.S. 1490 L.M.22....	,,	210	0	0

		£	s.	d.
†Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	142	10	0
B.S. 1490 L.M.2	,,	152	0	0
B.S. 1490 L.M.4	,,	169	0	0
B.S. 1490 L.M.6	,,	186	0	0

†Average selling prices for mid October

		£	s.	d.
***Aluminium Bronze**				
BSS 1400 AB.1......	ton	227	0	0
BSS 1400 AB.2......	,,		—	
***Brass**				
BSS 1400-B3 65/35 ..	,,	147	0	0
BSS 249............	,,		—	
BSS 1400-B6 85/15 ..	,,		—	
***Gunmetal**				
R.C.H. 3/4% ton	,,		—	
(85/5/5/5)	,,	182	0	0
(86/7/5/2)	,,	193	0	0
(88/10/2/1)..........	,,	241	0	0
(88/10/2/½)..........	,,	252	0	0
Manganese Bronze				
BSS 1400 HTB1....	,,	185	0	0
BSS 1400 HTB2....	,,	183	0	0
BSS 1400 HTB3....	,,		—	
Nickel Silver				
Casting Quality 12%	,,		nom.	
,, ,, 16%	,,		nom.	
,, ,, 18%	,,		nom.	
***Phosphor Bronze**				
B.S. 1400 P.B.1.(A.I.D. released)	,,	273	0	0
B.S. 1400 L.P.B.1	,,	202	0	0
Phosphor Copper				
10%	,,	242	0	0
15%	,,	245	10	0

**Average prices for the last week-end.*

		£	s.	d.
Phosphor Tin				
5%	ton		—	
Silicon Bronze				
BSS 1400-SB1	,,		—	
Solder, soft, BSS 219				
Grade C Tinmans....	,,	357	3	0
Grade D Plumbers..	,,	288	0	0
Grade M	,,	391	9	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 ,,	,,		—	
Zinc Alloys				
Mazak III	ton	106	1	3
Mazak V	,,	110	1	3
Kayem	,,	116	1	3
Kayem II	,,	122	1	3
Sodium-Zinc	lb.		2	6

SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium		£	s.	d.
Sheet 10 S.W.G.	lb.		2	8½
Sheet 18 S.W.G.	,,		2	10½
Sheet 24 S.W.G.	,,		3	1½
Strip 10 S.W.G.	,,		2	8½
Strip 18 S.W.G.	,,		2	9½
Strip 24 S.W.G.	,,		2	11
Circles 22 S.W.G.	,,		3	2½
Circles 18 S.W.G.	,,		3	1½
Circles 12 S.W.G.	,,		3	0½
Plate as rolled	,,		2	8
Sections	,,		3	2
Wire 10 S.W.G.	,,		2	11½
Tubes 1 in. o.d. 16 S.W.G.	,,		4	1

		£	s.	d.
Aluminium Alloys				
BS1470. HS10W.	lb.			
Sheet 10 S.W.G.	,,		3	1
Sheet 18 S.W.G.	,,		3	3½
Sheet 24 S.W.G.	,,		3	11
Strip 10 S.W.G.	,,		3	1
Strip 18 S.W.G.	,,		3	2½
Strip 24 S.W.G.	,,		3	10½
BS1477. HP30M.				
Plate as rolled......	,,		2	11
BS1470. HC15WP.				
Sheet 10 S.W.G.	lb.		3	9½
Sheet 18 S.W.G.	,,		4	2
Sheet 24 S.W.G.	,,		5	0½
Strip 10 S.W.G.	,,		3	10½
Strip 18 S.W.G.	,,		4	2
Strip 24 S.W.G.	,,		4	9½
BS1477. HPC15WP.				
Plate heat treated....	,,		3	6½
BS1475. HG10W.				
Wire 10 S.W.G.	,,		3	10½
BS1471. HT10WP.				
Tubes 1 in. o.d. 16 S.W.G.	,,		5	0¼
BS1476. HE10WP.				
Sections	,,		3	1½
Beryllium Copper				
Strip	,,	1	4	11
Rod..............	,,	1	1	6
Wire	,,	1	4	9
Brass Tubes..........	,,		1	10
Brazed Tubes........	,,		—	
Drawn Strip Sections	,,		—	
Sheet	ton		—	
Strip	,,	249	5	0
Extruded Bar........	lb.		1	11⅞
Extruded Bar (Pure Metal Basis)	,,		—	
Condenser Plate (Yellow Metal)	ton	186	0	0
Condenser Plate (Naval Brass)	,,	197	0	0
Wire	lb.		2	7¼
Copper Tubes	lb.		2	2¼
Sheet	ton	261	0	0
Strip	,,	261	0	0
Plain Plates	,,		—	
Locomotive Rods	,,		—	
H.C. Wire	,,	282	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	6½
Lead Pipes (London) ..	ton	112	5	0
Sheets (London)	,,	110	0	0
Tellurium Lead	,,	£6 extra		
Nickel Silver				
Sheet and Strip 7% ..	lb.		3	7¼
Wire 10%	,,		4	2¼
Phosphor Bronze				
Wire	,,		4	0¼

Titanium (1,000 lb. lots)			
Billet over 4″ dia.-18″ dia.	lb.	63/-	64/-
Rod 4″ dia.-·250″ dia.	,,	75/-	112/-
Wire under ·250″ dia.-·036″ dia.	,,	146/-	222/-
Sheet 8′ × 2′ × ·250″-·010″ thick	,,	88/-	157/-
Strip ·048″-·003″ thick	,,	100/-	350/-
Tube (representative gauge)	,,		300/-
Extrusions	,,		120/-

		£	s.	d.
Zinc Sheets, English destinations	ton	110	5	0
Strip	,,		nom.	

Financial News

Metal Statistics

Detailed figures of the consumption and output of non-ferrous metals for the month of Nov., 1958, have been issued by the British Bureau of Non-Ferrous Metal Statistics, as follow in long tons:—

COPPER	Gross Weight	Copper Content
Wire	30,593	30,210
Rods, bars and sections	11,677	7,772
Sheet, strips and plate	11,633	9,160
Tubes	7,120	6,557
Castings and miscellaneous	6,965	—
Sulphate	3,272	—
	71,260	60,219

Of which:

Consumption of Virgin Copper	47,932
Consumption of Copper and Alloy Scrap (Copper Content)	12,287

ZINC	
Galvanizing	8,169
Brass	7,974
Rolled Zinc	2,221
Zinc Oxide	2,086
Zinc Die-casting alloy	4,275
Zinc Dust	839
Miscellaneous Uses	868
Total, All Trades	26,432

Of which:

High purity 99·99 per cent	4,495
Electrolytic and high grade 99·95 per cent	4,520
Prime Western, G.O.B. and debased	9,772
Remelted	433
Scrap Brass and other Cu alloys	4,473
Scrap Zinc, alloys and residues	2,541

ANTIMONY	
Batteries	107
Other Antimonial Lead	45
Bearings	27
Oxides—for White Pigments	116
Oxides—other	89
Miscellaneous Uses	18
Sulphides	4
Total Consumption	406

Antimony in Scrap	
For Antimonial Lead	377
For Other Uses	32
Total Consumption	409

LEAD	
Cables	8,113
Batteries	2,529
Battery Oxides	2,377
Tetra Ethyl Lead	2,023
Other Oxides and Compounds	2,364
White Lead	747
Shot	315
Sheet and Pipe	5,659
Foil and Collapsible Tubes	329
Other Rolled and Extruded	463
Solder	1,080
Alloys	1,619
Miscellaneous Uses	1,168
Total	28,786

CADMIUM	
Plating Anodes	43·20
Plating Salts	8·90
Alloys: Cadmium Copper	6·45
Alloys: Other	2·30
Batteries: Alkaline	3·80
Batteries: Dry	0·45
Solder	5·05
Colours	19·10
Miscellaneous Uses	2·10
Total Consumption	91·35

TIN	
Tinplate	880
Tinning:	
Copper Wire	43
Steel Wire	8
All other	66
Solder	199
Alloys	449
Foil and Collapsible Tubes, etc.	47
Tin Compounds and Salts	81
Miscellaneous Uses	14
Total Consumption	2,795

Trade Publications

Carbide Tipped Saws.—Firth Brown Tools Limited, Carlisle Street East, Sheffield, 4.

An eight-page leaflet illustrating and describing the company's Speedicut Mitia carbide tipped saws for cutting a variety of materials, including non-ferrous metals, aluminium casting risers, lightweight refractory bricks, graphite, etc., has been issued by this company.

Lubrication Aids.—Mobil Oil Company Ltd., Caxton House, Westminster, London, S.W.1.

Two leaflets are being distributed, drawing attention to the subject of high-temperature grease lubrication and the qualities of Mobiltemp Grease No. 1.

Welding Notes. — Suffolk Iron Foundry (1920) Ltd., Sifbronze Works, Stowmarket, Suffolk.

The current (Winter) issue of "Sif-Tips" is very largely devoted to the problems of welding in agricultural machinery. Instances of repair work carried out on a very wide range of farm machinery and implements are described and illustrated. A section is also devoted to fabrication.

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 20/1/59.

	£
Aluminium	
New Cuttings	144
Old Rolled	124
Segregated Turnings	93
Brass	
Cuttings	148
Rod Ends	140
Heavy Yellow	113
Light	108
Rolled	138
Collected Scrap	111
Turnings	133
Copper	
Wire	200
Firebox, cut up	192
Heavy	188
Light	183
Cuttings	200
Turnings	179
Braziery	153

	£
Gunmetal	
Gear Wheels	178
Admiralty	178
Commercial	154
Turnings	149
Lead	
Scrap	62
Nickel	
Cuttings	—
Anodes	520
Phosphor Bronze	
Scrap	154
Turnings	149
Zinc	
Remelted	54
Cuttings	45
Old Zinc	34

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton):—

West Germany (D-marks per 100 kilos):

Used copper wire	(£192.15.0)	220
Heavy copper	(£188.7.6)	215
Light copper	(£162.0.0)	185
Heavy brass	(£109.10.0)	125
Light brass	(£87.12.6)	100
Soft lead scrap	(£58.12.6)	67
Zinc scrap	(£38.10.0)	44
Used aluminium unsorted	(£78.16.0)	90

France (francs per kilo):

Copper	(£187.10.0)	250
Heavy copper	(£187.10.0)	250
Light brass	(£116.5.0)	155
Zinc castings	(£47.5.0)	63
Lead	(£67.10.0)	90
Tin	—	
Aluminium	(£101.5.0)	135

Italy (lire per kilo):

Aluminium soft sheet clippings (new)	(£197.12.6)	335
Aluminium copper alloy	(£126.17.6)	215
Lead, soft, first quality	(£82.12.6)	140
Lead, battery plates	(£47.5.0)	80
Copper, first grade	(£203.10.0)	345
Copper, second grade	(£191.15.0)	325
Bronze, first quality machinery	(£203.10.0)	345
Bronze, commercial gunmetal	(£174.0.0)	295
Brass, heavy	(£138.12.6)	235
Brass, light	(£126.17.6)	215
Brass, bar turnings	(£129.17.6)	220
New zinc sheet clippings	(£59.0.0)	100
Old zinc	(£44.5.0)	75

THE STOCK EXCHANGE

Markets Easier But Remained Active

ISSUED CAPITAL ●	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 20 JANUARY	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1958 HIGH	1958 LOW	1957 HIGH	1957 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation	23/6		9	10	7 13 3	24/9	17/6	28/3	18/-
400,000	2/-	Anti-Attrition Metal	1/6		4	8½	5 6 9	1/9	1/3	2/6	1/6
38,305,038	Stk. (£1)	Associated Electrical Industries	57/9	+6d.	15	15	5 4 0	58/9	46/6	72/3	47/9
1,609,032	1	Birfield	58/3	+1/-	15	15	5 3 0	62/4½	46/3	70/-	48/9
3,196,667	1	Birmid Industries	76/6	+1/9	17½	17½	4 11 6	77/6	55/3	80/6	55/9
5,630,344	Stk. (£1)	Birmingham Small Arms	39/6	—7½d.	11	10	5 11 6	39/-	23/9	33/-	21/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/-		5	5	6 13 3	16/1½	14/7½	16/-	15/-
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/9		6	6	6 15 3	17/4½	16/6	19/-	16/6
500,000	1	Bolton (Thos.) & Sons	27/6	+9d.	10	12½	7 5 6	28/9	24/-	30/3	28/9
300,000	1	Ditto Pref. 5%	15/-		5	5	6 13 3	16/-	15/-	16/9	14/3
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/6		7	7	6 16 6	20/4½	19/-	22/3	18/9
9,000,000	Stk. (£1)	British Aluminium Co.			12	12		84/-	36/6	72/-	38/3
1,500,000	Stk. (£1)	Ditto Pref. 6%	19/6		6	6	6 3 0	20/-	18/4½	21/6	18/-
15,000,000	Stk. (£1)	British Insulated Callender's Cables	48/6		12½	12½	5 3 0	52/6	38/9	55/-	40/-
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord.	53/3	+1/9	10	10	3 15 3	52/-	28/3	39/-	29/6
600,000	Stk. (5/-)	Canning (W.) & Co.	25/-	—6d.	25+ *2½C	25	5 0 0	25/3	19/3	24/6	19/3
60,484	1/-	Carr (Chas.)	1/4½		12½	25	10 0 0	2/3	1/4½	3/6	2/1½
150,000	2/-	Case (Alfred) & Co. Ltd.	5/-	+3d.	25	25	10 0 0	5/3	4/-	4/6	4/-
555,000	1	Clifford (Chas.) Ltd.	22/6		10	10	8 17 9	22/-	16/-	20/6	15/9
45,000	1	Ditto Cum. Pref. 6%	15/3		6	6	7 17 6	16/-	15/-	17/6	16/-
250,000	2/-	Coley Metals	3/-		20	25	13 6 9	4/6	2/6	5/7½	3/9
8,730,596	1	Cons. Zinc Corp.†	64/3		18¾	22½	5 16 9	65/3	41/-	92/6	49/-
1,136,233	1	Davy & United	88/-	+1/-	20	15	4 11 0	87/-	45/9	60/6	42/6
2,915,000	5/-	Delta Metal	24/6		30	*17½	6 2 6	25/-	17/7½	28/6	19/-
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	41/6	+2/-	12½	15B	6 0 6	38/-	22/9	38/6	25/-
750,000	1	Evered & Co.	30/-		15Z	15	6 13 3	30/-	26/-	52/9	42/-
18,000,000	Stk. (£1)	General Electric Co.	40/-	+1/3	10	12½	5 0 0	40/6	29/6	59/-	38/-
1,500,000	Stk. (10/-)	General Refractories Ltd.	37/9		20	17½	5 6 0	39/3	27/3	37/-	26/9
401,240	1	Gibbons (Dudley) Ltd.	66/6		15	15	4 10 3	67/6	61/-	71/-	53/-
750,000	5/-	Glacier Metal Co. Ltd.	7/-		11½	11½	8 4 3	8/3	5/-	8/1½	5/10½
1,750,000	5/-	Glynwed Tubes	18/9	+2/-	20	20	5 6 9	18/1½	12/10½	18/-	12/6
5,421,049	10/-	Goodlass Wall & Lead Industries	30/9	+1/9	13‖	18Z	4 4 6	30/9	17/3	37/3	28/9
342,195	1	Greenwood & Batley	82/6xd	+26/-	20	17½	4 17 0	57/9	45/-	50/-	46/-
396,000	5/-	Harrison (B'ham) Ord.	15/-		*15	*15	5 0 0	15/9	11/6	16/9	12/4½
150,000	1	Ditto Cum. Pref. 7%	19/6		7	7	7 3 6	19/9	18/4½	22/3	18/7½
1,075,167	5/-	Heenan Group	7/4½	—6d.	10	10‡	6 15 6	9/7½	6/9	10/4½	6/9
236,958,260	Stk. (£1)	Imperial Chemical Industries	35/1½	—10½d.	12Z	10	4 11 3	38/-	24/3	46/6	36/3
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	16/6		5	5	6 1 3	17/1½	16/-	18/6	15/6
14,584,025	**	International Nickel	159¾	+1¾	$2.60	$3.75	2 18 0	169	132¾	222	130
860,000	5/-	Jenks (E. P.), Ltd.	9/6	—3d.	14	27½φ	7 7 3	10/-	6/7½	18/10½	15/1½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/-		5	5	6 5 0	16/9	15/-	17/-	14/6
3,987,435	1	Ditto Ord.	45/-		10	10	4 9 0	47/-	36/6	58/9	40/-
600,000	10/-	Keith, Blackman	25/-	—9d.	17½E	15	7 0 0	28/9	15/-	21/9	15/-
160,000	4/-	London Aluminium	5/9		10	10	6 19 3	6/-	3/-	6/9	3/6
2,400,000	1	London Elec. Wire & Smith's Ord.	74/-xd	+1/6	15	12½	4 1 0	74/-	39/9	54/6	41/-
400,000	1	Ditto Pref.	24/9		7½	7½	6 1 3	24/3	22/-	25/3	21/9
765,012	1	McKechnie Brothers Ord.	45/-	—6d.	15	15	6 13 3	45/-	32/-	48/9	37/6
1,530,024	1	Ditto A Ord.	42/6		15	15	7 1 3	45/-	30/-	47/6	36/-
1,108,268	5/-	Manganese Bronze & Brass	14/-		20	27½‡	7 2 9	14/1½	8/9	21/10½	7/6
50,628	6/-	Ditto (7½% N.C. Pref.)	6/-		7½	7½	7 10 0	6/3	5/6	6/6	5/-
13,098,855	Stk. (£1)	Metal Box	69/3		11	11	3 3 6	73/3	40/6	59/-	40/3
415,760	Stk. (2/-)	Metal Traders	8/9	—3d.	50	50	11 8 6	9/-	6/3	8/-	6/3
160,000	1	Mint (The) Birmingham	22/-		10	10	9 1 9	22/9	19/-	25/-	21/6
80,000	5	Ditto Pref. 6%	70/6		6	6	8 10 3	83/6	69/-	90/6	83/6
3,705,670	Stk. (£1)	Morgan Crucible A	44/6		10	10	4 10 0	45/-	34/-	54/-	35/-
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref.	18/-		5½	5½	6 2 3	18/-	17/-	19/3	16/-
2,200,000	Stk. (£1)	Murex	47/6	+2/3	17½	20	7 7 6	58/9	46/-	79/9	57/-
468,000	5/-	Ratcliffs (Great Bridge)	11/3	+3d.	10	10	4 9 0	11/1½	6/10½	8/-	6/10½
234,960	10/-	Sanderson Bros. & Newbould	27/3		20	27½D	7 6 9	27/3	24/6	41/-	24/9
1,365,000	Stk. (5/-)	Serck	18/3	—3d.	15	17½	4 2 3	18/7½	11/-	18/10½	11/6
6,698,586	Stk. (£1)	Stone-Platt Industries	45/9		15	12½	6 11 0	45/6	22/6	33/4½	22/7½
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	16/1½		5½	5½	6 16 6	16/3	12/7½	14/-	12/9
14,494,862	Stk. (£1)	Tube Investments Ord.	74/-	—1/9	17½	15	4 15 0	86/-	48/4½	70/9	50/6
41,000,000	Stk. (£1)	Vickers	36/6		10	10	5 9 6	36/3	28/9	46/-	29/-
750,000	Stk. (£1)	Ditto Pref. 5%	15/-		5	5	6 13 3	15/9	14/3	18/-	14/-
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	22/3	—3d.	*5	*5	6 18 9A	23/-	21/3	24/9	20/7½
2,200,000	1	Ward (Thos. W.), Ord.	86/-		20	15	4 13 0	87/3	70/9	83/-	64/-
2,666,034	Stk. (£1)	Westinghouse Brake	42/9	—1/6	10	18P	4 13 6	46/6	32/6	85/-	29/1½
225,000	2/-	Wolverhampton Die-Casting	8/10½		30	25	6 15 3	10/1½	7/-	10/1½	7/-
591,000	5/-	Wolverhampton Metal	22/-	—1½d.	27½	27½	6 5 0	22/9	14/9	22/3	14/9
78,465	2/6	Wright, Bindley & Gell	5/-xd		20	20	10 0 0	5/4½	2/9	3/9	2/7½
124,140	1	Ditto Cum. Pref. 6%	13/-		6	6	9 4 6	13/-	11/3	12/6	11/3
150,000	1/-	Zinc Alloy Rust Proof	3/-	+1½d.	27	40D	9 0 0	3/1½	2/7½	5/-	2/9

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting **Shares of no Par Value. ‡ and 100% Capitalized Issue. ●The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/- per share for £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. φ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits. E and 50% Capitalized issue in 7% 2nd Pref. Shares.

B

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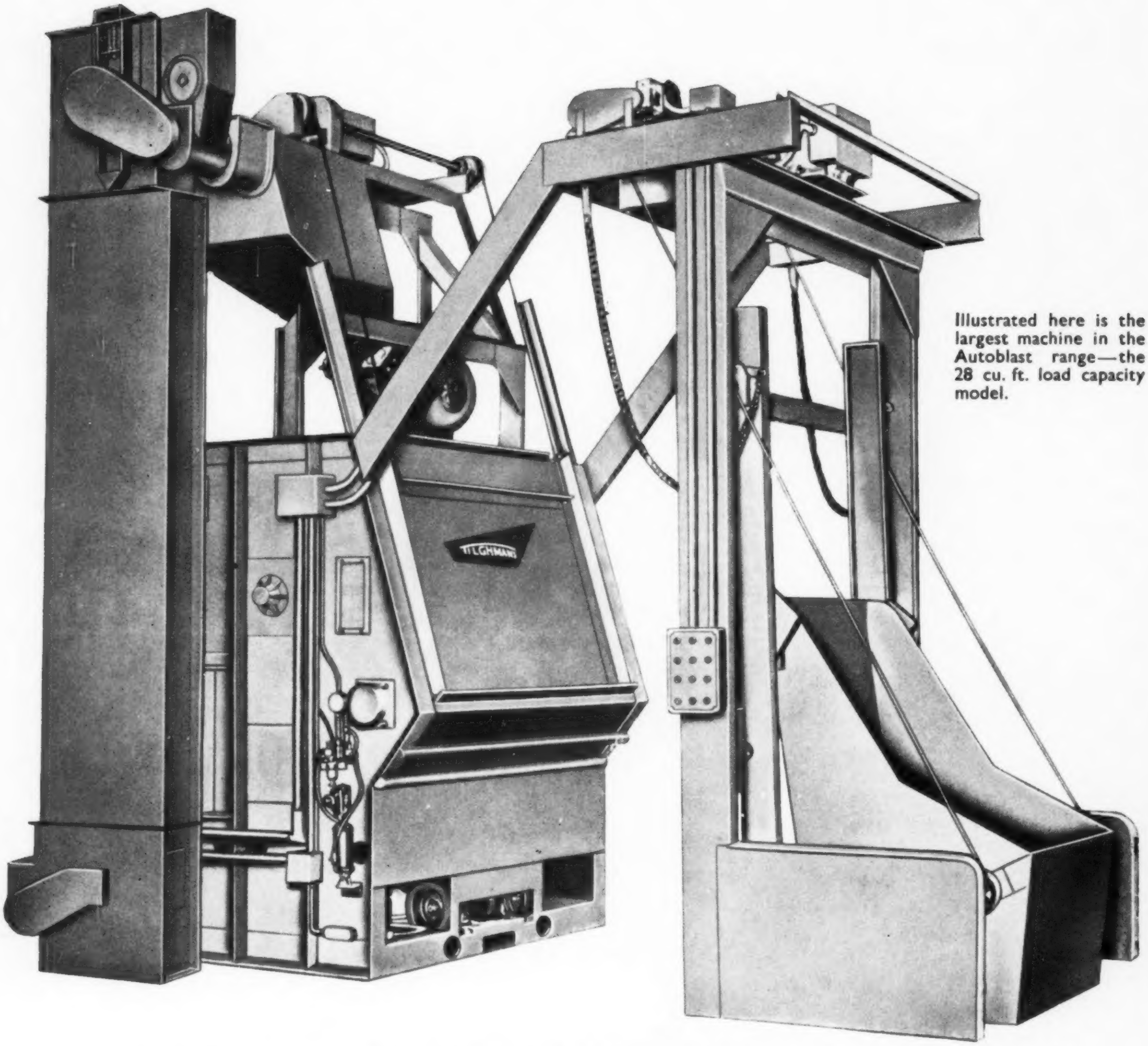

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